ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR

125872

OF THE

STATE OF NEW YORK,

For the Fiscal Year Ending September 30, 1897.

TRANSMITTED TO THE LEGISLATURE FEBRUARY 7, 1898.

WYNKOOP HALLENBECK CRAWFORD CO.,

STATE PRINTERS,

NEW YORK AND ALBANY.

1898.

STATE OF NEW YORK.

No. 67.

IN ASSEMBLY,

FEBRUARY 7, 1898.

ANNUAL REPORT

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STATE ENGINEER AND SURVEYOR.

ALBANY, *February* 7, 1898.

To the Honorable the Speaker of the Assembly:

SIR.— I have the honor to transmit herewith my annual report for the fiscal year ending September 30, 1897.

CAMPBELL W. ADAMS,

State Engineer and Surveyor.

REPORT.

Office of the State Engineer and Surveyor,
Albany, N. Y., *February* 7, 1898.

To the Honorable the Legislature of the State of New York:

New York State is exceptionally endowed with natural advantages for the attraction of a large population, and the creation and accommodation of a great commerce. The shores of eight populous, industrious and growing states are washed by the waters of the great lakes, and to the north, and sharing in the ownership and use of these expansive stretches of navigable waters, is another nation, alien, but of common ancestry and tongue.

Fortunately situated at the eastern extremity of these waters, New York stands as the natural outlet for the commerce created in or contributory to the States bordering on the great lakes. But this eastern extremity of the chain of lakes is the western boundary of the State of New York, across whose broad acres this rich, continuous and expanding commerce must find its way to the sea. In supplementing the natural advantages thus possessed by the State in the construction of the Erie canal, the statesmen of a century ago builded infinitely wiser than they knew, but with a prescience, nevertheless, which has placed us, their successors, under debts of gratitude which we should never cease to proclaim, not necessarily by empty and perhaps forgotten words, but by seeing to it, as a State, that we most jealously guard this great heritage as the richest jewel in our commercial casket—the very well-spring of our industrial life.

Along our northern border stretches a great competitive highway, the possession of an alert, restless and ambitious people, to whom an active commerce is the very breath of their nostrils. These people are toiling for and dreaming of the day when the commerce that has enriched and made New York the Empire State of the Union shall be diverted by their own St. Lawrence to the sea and thence to the uttermost parts of the earth. As we note the earnest efforts and heed the generous sacrifices made by our northern commercial rivals, and as we meet them with increasing accommodations for our growing traffic, we shall demonstrate our ability to retain our commercial supremacy.

Within sight of Canada's commercial metropolis, almost, a canal taps the St. Lawrence, which leads to Lake Champlain, at the southern end of which the enterprise and industry of our early-day statesmen constructed the Champlain canal, by which the St. Lawrence and the Hudson are united in one unbroken navigable highway.

To the east, Long Island Sound and the Atlantic Ocean, and to the south and west the Raritan river and its tributaries, all contribute, along waterways of ample depth and commodious breadth, another highway of commerce that New York has but to take full advantage of to defy for all time the most strenuous efforts of rival States to either equal or measurably approach.

Thus it is that the people of New York, in days gone by, have supplemented the bounties of nature by the creation of these artificial waterways that have, with their natural connections, made of New York a huge artificial island, pierced and surrounded by navigable streams, all bearing their rich and enriching burdens of commerce.

A glance backward is instructive, as showing whether New York has always been the great commercial center of this continent that it is now. In a publication issued by the Federal government is found a compilation of "Trade between the American Colonies and Great Britain," copied from "Hazard's Commercial and Statistical Register," extending back just two centuries, but closing with 1776. The then impending war makes it inadvisable to show by periodic contrast the commerce of the year 1776, which had fallen to almost nothing, wherefore the year 1774 is selected to close the accompanying table, as being a fairer indication of the comparative trade of the several colonies quoted. In periods of ten years apart, therefore, with the single exception just indicated, will be shown the trade, expressed in pounds, English money, thus conducted, and as shared by New England, New York, Virginia, Maryland and Carolina, which were during that period the leading American colonies.

Table showing the trade between the American colonies and Great Britain, between 1697 and 1774, in ten-year periods.

YEAR.	NEW ENGLAND.		NEW YORK.		VIRGINIA AND MARYLAND.		CAROLINA.	
	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.
1697	26,282	68,468	10,093	4,579	227,756	58,796	12,374	5,289
1707	38,796	120,631	14,283	29,855	207,625	237,901	23,311	10,492
1717	58,898	132,001	24,534	44,140	296,884	215,962	41,275	25,058
1727	75,052	187,277	31,617	67,452	421,588	192,965	96,055	23,254
1737	63,347	223,923	16,833	125,833	492,246	211,301	187,758	58,986
1747	41,771	210,640	14,992	137,984	492,619	280,088	107,500	95,529
1757	27,556	363,404	19,168	353,311	418,881	426,687	130,889	213,949
1767	128,207	406,081	61,422	417,957	437,936	437,628	395,027	244,093
1774	112,248	562,476	80,008	437,937	612,030	528,738	432,302	378,116

It is impossible, and it would be unsatisfactory, to carry this compilation down during the period of the Revolution. Even the six years of stagnation that succeeded the close of that struggle would give but little, if any, indications of the real relative commercial strength of the several new states. After the United

States had secured a stable and strong government under the new Constitution, commercial statistics were not gathered with such a degree of accuracy as to merit absolute reliance upon them. For instance, up to 1821, when the methods of statistical compilation now in vogue were adopted by the general government, there is nothing to show the relative proportions of imports received in the several States, except by a comparison of the duties collected therein. Fortunately, however, the statistics of exports were more carefully compiled, on which account it is possible to present by States the value of their exports, which will be done in the following table, in ten-year periods, beginning with the year 1791:

Table showing the exports from the leading Atlantic and Gulf States during 110 *years, in ten-year periods, expressed in dollars.*

YEAR.	Massachusetts exports.	New York exports.	Pennsylvania exports.	1	South Carolina exports.	Louisiana exports.
1791......	$2,519,651	$2 [illegible] 55	$3,463,099		$2,693,268	....
1801......	14,870,556	19 [illegible] 36	17,438,193		14,304,045	....
1811......	11,235,465	12 [illegible] 16	9,560,117		4,861,279	$2,650,050
1821......	12,484,691	13 [illegible] 17	7,391,767		7,200,511	7,272,172
1831......	7,733,768	25 [illegible] 14	5,518,718		6,575,201	16,761,989
1841......	11,487,348	33 [illegible] 10	3,770,727		8,043,284	34,387,483
1851......	12,352,692	86 [illegible] 52	5,856,036		15,316,578	54,413,963
1861......	16,572,736	158 [illegible] 18	10,013,097		5.455,581	*108,417,798
1871......	14,701,390	308 [illegible] 22	18,026,900		12,546,010	95,246,791
1881......	73,544,292	411 [illegible] 25	44,245,065		29'169,402	103,835,249
1891......	77,103,314	354 [illegible] 72	23,676,595		22,909,141	109,108,953

* 1860.

In order that the study of our imports by States may be made comparatively, as nearly as the statistics available will permit, the following table will contain, under the names of the several States already enumerated above, for the ten-year periods 1791, 1801 and 1811, the amount of customs duties collected, and thereafter, in ten-year periods, beginning with 1821, and ending with 1891, the actual imports by States:

Table showing the customs duties collected in ten-year periods from 1791 *to* 1811, *inclusive, and thereafter, in ten-year periods, the imports by States from* 1821 *to* 1891, *both inclusive, expressed in dollars.*

CUSTOMS DUTIES ON FOREIGN MERCHANDISE IMPORTED.

YEAR.	Massachusetts.	New York.	Pennsylvania.	Maryland.	Virginia.	South Carolina.	Louisiana.
1791.....	$1,025,974	$1,356,064	$1,475,428	$641,648	$605,887	$109,694	....
1801.....	4,442,577	4,964,225	3,702,898	2,157,649	622,154	141,781	....
1811.....	2,772,074	2,436,092	2,364,635	1,032,364	214,204	63,953	$166,029
IMPORTS.							
1821.....	14,826,782	23 629,246	$2[illegible]22	4[illegible]12	1,078,490	3,007,113	3,379,717
1831.....	14,269,056	57,077,417	1[illegible]33	4[illegible]77	485,522	1,238,163	9,766,693
1841.....	20,318,003	75,713,426	1[illegible]98	6[illegible]12	377,237	1,557,431	10,256,350
1851.....	32,715,327	141,546,538	1[illegible]31	6[illegible]15	552,933	2,081,312	12,528,460
1861.....	45,399,844	237,402,726	1[illegible]18	9[illegible]35	791,907	806,480	*22,922,779
1871.....	54,239,272	376,951,804	1[illegible]15	24[illegible]34	188,287	621,808	19,427,238
1881.....	62,356,725	453,969,119	3[illegible]36	16[illegible]16	236,776	787,632	12,218,920
1891.....	71,416,501	556,868,717	6[illegible]31	20[illegible]97	196,384	1,088,731	20,267,060

* 1860.

There is much that is valuable and impressive in these data. They can not be deeply studied and carefully reflected upon without suggesting the probable reasons for the growth and decline of States. No State can be great and not possess an active commerce. Decay awaits stagnation. Whatever the causes that lead to a decline in commerce, they are the causes that sap the life of the State. Let this indicator be long unobserved, and the seeds of decay may have become so deeply implanted that the most radical remedies and the most careful nursing will be necessary to secure relief and recovery. New York has not reached this stage, as yet. It never should, and it never will, if its people are but alive to their duties and their opportunities.

Imports have been the great bed-rock of our commercial superstructure, for nearly a century. Even back of that, however, while our commercial growth, in imports, was as remarkable as it was rapid, yet, at one period, at least, Massachusetts slightly led. It required seventy long years for New York to pass New

England, before the Revolution, in the matter of imports. And we have but to refer to the record to see how tenaciously Massachusetts held to New York during the first twenty years of our national life. These lessons are impressive. They must not be forgotten. It may not be New England that we need fear again, but the commerical conqueror of New York may be to the south, nevertheless, but quite unlikely in the west. During the last century Virginia and Maryland were invulnerable, commercially. The value of their commerce was almost continuously double that of any of the other colonies, but Carolina became remarkably vigorous and expansive just preceding the Revolution. Indeed, that colony pressed hard upon New York, and passed her with flying colors in the early part of the last century, a lead which she held until the Revolutionary war changed things. But even after the new constitution had gone into effect, while New York far exceeded South Carolina in the matter of imports, yet the latter led New York in the volume of her exports.

So, we see, commerce has no hard and fast abiding place. It is as mobile as the water that floats it. This is a fact never to be lost sight of. The mutations of time have dealt hardly with some of our States, commercially, as the data tabulated above will show. In exports Massachusetts, Pennsylvania, Virginia and South Carolina all led New York a hundred years ago. In exports, as we shall see presently, Louisiana led New York for several successive years just preceding the civil war. That war was disastrous to Louisiana in many ways, but in none so disastrous as commercially. It has required a third of a century for Louisiana to recover, and she has not even done so yet, while New York has been advancing, not so steadily as she might, but to a degree that Louisiana might well envy.

The wealth of an empire is New York's, all because of the indomitable energy and far-seeing statesmanship of the heroic figures of a century ago.

Where the ship brings her import cargo, there she will also seek her export cargo, and a profitable business is assured to the port that can measureably command both, in a fair degree of proportion. The character of the exports of the United States, their bulkiness as compared with their value, still assures to New York this boon. Ships still come here in ballast, and few leave without cargoes. But there is, nevertheless, a proportional decline to be noted in New York's export business that will, later, be dwelt upon, and some of the causes explained, more in detail.

One of the present strongest reliances of New York, is the large and growing population. So long as this growth continues, its supremacy in commerce may be reasonably expected. A population so dense as that inhabiting the port of New York, and its suburbs, creates a vast commerce in the carrying of the things that are consumed, and in bringing away the surplus productions that are sold.

There is a weakness in the very strength of the port of New York, in this very respect. While New York is by far the leading manufacturing city in the United States, yet there is a danger in the fact that the things manufactured are produced from materials often brought from long distances. And the things manufactured are often carried equally long distances before being sold. When matters reach that stage of perfection that the point of producing manufactures comes nearer to the place where the raw materials used are produced, New York's manufacturing and commercial danger will be much more imminent

than now. Commerce being a product of transportation, we must see to it, and that vigilantly, that the cost of transportation, by being constantly at the minimum, shall be the least disturbing factor in our industrial and commercial growth. As transportation is cheapened, production increases, and commerce grows. The distance from which materials may be brought to be consumed and transformed into manufactures may be still further removed from the point of manufacture, if the cost of transportation may be lowered. The lowering of the cost of transportation cheapens the cost of living, and enables us to consume more. There is a double advantage, and especially to a community like New York, in cheapened transportation. It not only affects the things brought to us, and reduces their cost, but the area in which the products of New York may be profitably sold increases with each reduction in the cost of transportation. Were the cost of transportation wholly eliminated, then, of course, the cost of production being equal, New York could compete with any other place. We must see to it, therefore, that every impediment to reduce transportation charges is removed, and that no others are permitted to rise up in their places.

Cheap transportation is New York's most vital necessity. Upon that hinges the success or failure of the business transacted. If it be low, business increases, profits are greater, industry is stimulated, foods are cheapened, and prosperity reigns on every hand. If it be high, business shrinks, profits are curtailed, labor is idle, foods are dearer, and misery and want take the place of industry and contentment.

Blessed, indeed, is the State, therefore, that possesses the means for minimizing transportation charges! In this respect New York is most signally fortunate, so fortunate, indeed, that its people

have even become indifferent to these very primary but vital truths. A State less fortunate than New York would have, from very necessity, been obliged to improve every opportunity to accomplish by alertness, vigilance, industry, perseverance and energy what New York, from its unparalleled advantages, has been able to neglect, and yet hold fast to.

New York's canals, the free gift of a great and prosperous people to commerce, must be utilized to their uttermost. Only by so doing, will the lowest transportation charges be steadily forced. As we relax in this respect, up go the rates and away goes the business. As we reapply ourselves to the problem of reduced transportation charges, and succeed, down go the rates and back comes the trade. The one is as inevitable as the other.

The accessories to commerce, sufficient docks, available warehouses, with every possible appliance that expedites and cheapens handling, must always be so ample, so numerous, so cheap, so accessible, as to always keep in advance of demand. However ample and extensive our waterways, if the means be not at hand for accommodating and at reasonable rates, all of the commerce that would naturally be attracted to these waterways, the beneficence of them is wasted. In this respect New York, the great City of New York, has been extravagantly wasteful.

These may seem trite, and even tiresome, truths. But the people of New York, both as a great municipality and as a greater State, have either forgotten or become so indifferent to them as to witness with apathy the loss of a commerce that any other port in the country would pour out millions upon millions to secure, and never abate its efforts to retain and increase.

While guarding with the most unrelaxing watchfulness and solicitude the adequacy and efficiency of our canals, let us not

imagine that our duty has been performed if, at terminals, conditions exist that practically nullify all that these canals are capable of accomplishing in the way of reduced transportation charges, in increased commerce and greater industry. There is the vital spot in which New York has been far too lax, too neglectful, too indifferent. Let the abuses and the obstacles existing at terminals be removed and every other reform will rapidly follow. Let the terminal abuses remain and no improvements in waterways will outweigh or overcome them. New York, as a city and as a State, must fearlessly face and determinedly master the commercial crisis that now confronts them both.

Our domestic commerce is something that should command much more of our attention than it receives. Whether it grows or shrinks, we know not. There is nothing being done, officially or unofficially, to tell us. It is a closed book. Its importance far outweighs the value or the volume of our foreign commerce. The latter is a reliable commercial thermometer, because of its unquestionable statistical accuracy under present methods of compilation. It is a duty that the State owes to its citizens that such steps should be taken as will enable its people to know whether the domestic commerce of the State is in the same boat with the foreign commerce. Some system can be devised, beyond a doubt, that will afford a basis for ascertaining how this is, and until it is known, we are but groping in the dark, perhaps. Once known, the weak points may be strengthened and fortified and the strong ones made still stronger. Knowing practically nothing, in this respect, practically nothing can be suggested for remedy, if, indeed, remedy is required.

So long have we believed that "westward the course of empire takes its way," that it is in that direction almost wholly in which

we have been wont to look for industrial growth. Many of us have had our eyes tightly shut to the growing importance of the New South, industrially and commercially. The rude shock which recent developments in cotton-manufacturing New England has given the country, has awakened unbounded surprise and much alarm. New England's manufacturing supremacy, and in cottons, is boldly challenged! The South is again in the saddle, but this time industrially. As we applaud, and as we admire, let us also study.

Why not New York, if New England's manufacturing pre-eminence is threatened? What will save New York if New England is in danger? If the South can conquer New England why not New York, in manufacturing? Shall we feel sorry for New England and glad for the South, and regardless of ourselves? The warning is written large for us if we will but read it. Indeed, we must read and understand it or we shall succumb.

As has previously been stated, New York is the greatest manufacturing State in the Union. We shall not lose our hold in a day. We need not lost it at all, if we but utilize our resources for cheap transportation. Accomplishing all that we are capable of in the direction of lowering freight charges, we shall be meeting new conditions properly. If the South to-day can transform its own raw materials into finished products, to the loss of New England, to-morrow the fate of New York may be in doubt. There is a gigantic struggle ahead, and New York must, commercially speaking, strip for the contest. Not a tithe of the things consumed in this State is produced within its borders. Transportation brings the raw materials here and transportation takes the finished products hence. How can we escape the force of the statement that our industrial and commercial supremacy hinges

upon the lowest possible transportation charges? How shall we secure them, except through the medium of our canals and natural waterways, with every accommodation for the handling of traffic that the ingenuity of man can devise?

When New York loses her commercial supremacy, gradually her manufacturing pre-eminence, her financial domination and finally her numerical strength will become impaired. As we force down transportation charges, we defer these losses and impairments.

As regulators of freight rates, New York's canals still exert a potential influence upon transportation routes. As these canals become inefficient their influence wanes. And, as we have shown, they may become inefficient wholly outside of their prisms and structures — at terminals. When the competing routes of transportation are able to put such a brake upon canal transportation efficiency as is the case in New York, the remedy lies in looking to the weapons in the hands of these competitors, and they must be disarmed of them.

Imports, because of their large value and small bulk, and because methods of handling and charges therefor are more uniform in all of our ports, New York included, have not seriously or appreciably diminished at the port of New York. During more than forty years, New York's proportion of the nation's entire imports has fluctuated around an average of two-thirds. There is warning in the fact, however, that it is forty years since New York's imports were such a small proportion of the nation's total as last year. And yet, last year it was 62.07 per cent. of the nation's total.

It is only the more bulky of our imports that are carried through the canals. Nevertheless the canals fix the rates of

freight charges, probably, upon many times more traffic than actually employs the canals. Therein are their great value and potency. It is not the traffic that the canals carry that is the measure of their influence or value, but the traffic upon which they fix the transportation rates. Hence, the attention that is drawn to the dwindling volume of canal commerce, with suggestions of their destroyed or lost influence or value, has behind it a motive that may be quite disinterested, but which will bear examination and watching. The diminution of canal traffic is an evidence that causes exist which impair their usefulness. It is still a truth that there is a large profit in canal transportation at rates one-half and even one-third of those that express the actual cost of competing rail transportation. It is a foregone conclusion, therefore, that it is not that canals are losing their value, but possibly their efficiency, that a diminished commerce suggests. The remedy is not to abandon the canals—which their rivals would welcome and the people would deplore—but to improve them, both in their prisms and at terminals, wherever their influence or value is impaired.

One of the conspicuous evils of present canal transportation is the lack of efficient organization in their operation. There is nothing to justify reliance upon the ability of the men now operating New York's canals to properly handle a larger traffic. The confidence reposed in business organizations is not extended to the men now engaged in navigating New York's canals, for the reason that they are irresponsible and unorganized, and are unable, as a consequence, to give the accommodations to commerce that competing routes, with higher transportation rates, are able to and do give. There must be better organization, under responsible management, and with no limitations upon its efforts.

Then the scope of their efforts will be very greatly and quite wisely extended. But this cannot even be inaugurated at present. The Legislature has seen fit to place a limit of $50,000 upon the amount of capital stock of corporations doing business upon the canals. At best, the difficulties of developing a business that shall be regular, systematized and permanent upon New York's canals will be many and perplexing, but this limitation of capital makes them insurmountable. Such a limitation at once precludes corporations from acquiring their own terminals, which latter are the prime essentials to a successful and stable business.

Everything that can be done ought to be be done to promote and facilitate transportation by the canals by the State. Considering the influence of low transportation rates upon industry, and which adequate and efficient canals compel, no insurmountable barrier in the way of securing that very thing ought to be upon the statutes of this State. It is the good of the State that the canals are constructed and maintained to serve, and for this reason the limitation upon the amount of capital stock of companies doing business upon the canals ought to be removed. No injury to the present canal boatmen would follow. But it is not the boatmen that New York's canals were constructed to serve, but commerce, and it is only served properly when it is transported at the minimum of expense. If corporations can profitably reduce the rates of transportation on the canals, then they serve the very purpose for which the canals were constructed, and for which they are maintained free of tolls. If corporations cannot reduce the cost of transportation, then they cannot injure the boatmen now doing business thereon. If corporations are willing to take the risk, therefore, of building up profitable business upon the canals, by utilizing them as they were intended to be utilized,

the State should welcome instead of repel them. They will serve the people if they reduce rates of transportation. They will merely ruin themselves if they fail to do this.

The great factor to-day in determining the point of shipment for exports is cheapness of transfer at the seaboard terminal. While canal rates may be low, transfer charges are always high, in New York, and the result is a diminished export business. New York's shortsightedness is her loss; it is also the gain of Boston and Baltimore, and Philadelphia and Newport News. To some extent the benefits are felt in New Orleans, and even in Galveston, of New York's commercial blindness. It is true that a railroad discrimination favors Philadelphia and Baltimore; so do New York's port charges favor those and other ports.

At Newport News the cost of transferring grain from railroad car to ship is such a trifle that it is not considered in the through freight charge. At New York it is a tangible and a formidable factor. New York's transfer charges are often as great as the transportation charges from Buffalo, 500 miles distant from New York. Of course New York cannot permit this forever. It becomes merely a question of how soon she will stop it, or her export trade, in cereals and flour, will have totally disappeared. But the expenses of handling grain at New York is a vital question to the people, because more comes here and is consumed here, than is exported. So, the people, too, are being mulcted in high charges for the handling of their food stuffs. The abatement of these charges enlarges the opportunities for profitable competitive production. As they are increased, industries will languish.

The State of New York may have done its duty by commerce when it constructed and while it maintains free of all tolls its canals. But it does not do its duty by its citizens when it permits

these canals, these natural attractors of commerce, these natural regulators of low transportation charges, to be throttled at either end of their length, and all of the good that they do become nullified. That is the situation to-day, and unless the State steps in and asserts its authority and exercises its right to remove every obstacle that now lies in the way of the freest and fullest use of the canals of which they are capable, its commerce will continue to proportionately diminish.

The canals are now being so improved as to accommodate boats with loads 64 per cent. larger than now. This improvement will be unavailing unless there are changes in New York's terminal charges.

Major Thomas W. Symons, an officer in the Engineer Corps, United States Army, stationed at Buffalo for several years, last year made a preliminary examination of the various suggested routes for a ship canal through the State of New York, under the direction of the Secretary of War. His report, rendered on June 23, 1897, covers 110 pages of printed matter, including several maps and illustrations of value. This report, known for identification purposes as "Document No. 86, House of Representatives, Fifty-fifth Congress, first session," is entitled "Preliminary Examination for a Ship Canal from the Great Lakes to the Navigable Waters of the Hudson River." Toward the end of this document, the officer in question describes the charges and methods for handling grain in Buffalo and in New York, in minute detail. What he says is pertinent to the discussion of New York's commerce. There is no reason to believe that any of his statements are erroneous. The writer has failed to see them challenged or contradicted.

The distance from Chicago to Buffalo is nearly 900 miles, and from Duluth to Buffalo just 1,000 miles. Lake ships are four and five days, respectively, in making the passage from the ports named to Buffalo, with grain cargoes. Lake ships charged an average of 1.35 cents a bushel for carrying wheat, from Chicago to Buffalo, and approximately the same rate from Duluth to Buffalo, in 1896. Major Symons says:

"The transfer charges at Buffalo includes the items in columns 6, 8 and 11, shoveling, elevating, and storing and trimming, amounting all told to 1.3 cents per bushel, or at the rate of 43 1-3 cents per ton."

A lake ship loaded with 5,000 bushels of wheat can be unloaded in eight or ten hours—a fractional part of the time the ship has consumed in carrying the cargo to the transfer elevator. And yet the elevator earns in eight or ten hours almost as much as the ship has earned in four or five days. On such a cargo, at the rate of 1.35 cents a bushel, the ship would earn $2,232.50, and the elevating and transferring charges at Buffalo on the same quantity would be $2,145—a difference of but $87.50. Major Symons continues his report:

"The transfer charges on grain are fixed arbitrarily by the Western Elevating Association of Buffalo, a combination controlling all the elevators, except a few small ones. The transfer charges at Buffalo are the source of complaint and dissatisfaction, and there is little doubt that they can be materially reduced and the business still transacted at a profit."

Major Symons proceeds:

"The Erie canal has no terminal facilities and no lines of lake vessels running in connection with canal lines, and so the canal boats as a general rule only get what freight they can pick up in Buffalo and Tonawanda."

When the Erie canal is improved, Major Symons estimates that wheat will be carried from Buffalo to New York, present transfer charges at Buffalo included, for 2.70 cents a bushel in four-boat fleets, and for six-boat fleets for 2.57 cents a bushel. The present charges, elevation included, are, respectively, 3.81 and 3.56 cents a bushel.

He recommends, as a project worthy of being undertaken by the Federal government, the construction of a 1,500 ton barge canal, at an approximate cost of $50,000,000. Four-boat fleets, adapted to the size of such a canal would reduce the cost of carrying wheat to Buffalo, present elevation charges included, just one-half of a cent a bushel, and five-boat fleets would reduce the cost 0.56 of a cent a bushel, he estimates. I am satisfied, however, that his estimate of cost of such a canal is far too low.

Major Symons says, in part, regarding New York's charges on grain:

"The terminal and harbor facilities at New York city are peculiar, and the cost of handling traffic is excessive."

He then describes the peculiarities of New York, in the matter of receiving, storing and shipping grain, and continues:

"In the transportation of grain from the western grain-producing and storing centers the trunk lines terminating in New York city for many years have made it part of the transportation agreement that they (the railroads) shall deliver the grain alongside of the ship without charge therefor, except as included in the freight rate.

"In pursuance of this agreement, the railroads transfer grain from their cars and through elevators into lighters, by which it is transported in the harbor alongside of vessels, and for which transportation or lighterage a charge of 3 cents per 100 pounds,

equal to 1.8 cents per bushel of wheat, is exacted by the lighterage companies doing the work."

Years ago, Major Symons continues, the railroads built stationary elevators for the accommodation of grain ships, and the saving of the expense. "A large and constantly growing business," he says, "was thus being built up, and the lighterage fee of 3 cents per 100 pounds saved." He adds:

"This mode of delivery conflicted materially with the operations of the floating elevators, whose operations were being gradually confined to transferring grain arriving in canal boats from the Erie canal. In order to allow the floating elevators to regain this business, and to prevent a threatened rate war with Boston railroads, a set of rules and tariff of charges was promulgated, under date of October 16, 1882, by the railroad elevators in the port of New York, and of which rule 5 reads as follows:

"'Receiving, weighing, and storing (grain) for the first 10 days, or any part thereof, ¼ of a cent per bushel, and an additional charge of 1 cent per bushel for all subsequent 10 days or parts of the same, so long as the grain remains in store and in good order.'"

Major Symons also states:

"It is believed that the actual cost of lighterage in New York harbor does not exceed one-half to three-quarters of a cent per 100 pounds."

The expense of transferring grain from lighter to ocean vessel he says is borne by the grain, the charge being 1.275 cents per bushel. Ocean vessels are also charged $2 for every 1,000 bushels loaded. There are also other small charges that help swell the aggregate, which Major Symons specifies. The railroads deliver grain free alongside the elevators in Brooklyn, but the charge

for placing it in them is the same as for transferring it to an ocean vessels, viz.: 1.275 cents per bushel. He adds:

"In cases where grain is lightered from the Brooklyn warehouses to alongside of ocean vessels and transferred to them, the charge is 2.0875 cents per bushel, to which must be added the usual storage and inspection charges."

Major Symons shows that the charge for transferring grain from canal boats to vessels is 1.125 cents a bushel. He specifies other charges that are also made, and says:

"Regarding the decline in the receipt of wheat (and other grain) at New York, it is claimed that this is brought about by the action of the Joint Traffic Association, of which a number of trunk line railroads are members, allowing certain Atlantic ports, such as Baltimore, Norfolk and Newport News, certain differences in rates, termed 'differentials.' The freight rates for the ports named are 3 cents per 100 pounds less than the New York rate, and this, it is claimed, has the effect of attracting trade to Baltimore, Norfolk and Newport News and withdrawing it from New York city."

There are some who seriously suggest the construction of a ship canal, to cost anywhere from $200,000,000 to $500,000,000, in order to lop off these charges, by making by-ports of Buffalo and New York. This would be a heroic way in which to abate a combination that could be purchased for $20,000,000 and probably duplicated for $5,000,000, and the annual expense of which would not exceed $500,000 for operation and maintenance.

But the quotations that have been made may explain why it is that *the port of New York which, a third of a century ago, commanded 73 per cent. of the total exports of the nation, to-day possesses but 37 per cent. of them.*

An attempt was made in 1888, by the passage of an act through the State Legislature, the constitutionality of which was sustained by the Supreme Court of the United States, to fix the charges for which grain should be transferred in this State, but it has been systematically evaded ever since its enactment.

While there is a steady increase in the commerce of the port of New York, and which has misled many people into believing that we are doing a little better than holding our own, we are only able to see how true this belief is in fact, by presenting, by percentages, New York's share of the nation's foreign commerce —imports and exports, which will be done in the tables that will follow, and which cover the import and export traffic of the ports of New York, Boston, New Orleans, Baltimore, Philadelphia and Galveston, the leading Atlantic and Gulf ports of the United States in the order named. Between 1861 and 1879, during the period when gold was at a premium, the value of our imports was always expressed in the publications of the government in gold, both for the ports and the total; but export values are expressed, by ports, in their mixed gold and currency values, although the total value for the nation is expressed in gold. This made necessary a very elaborate and complicated process of calculations, in order to bring the export values by ports, down to the common gold standard, and which has been accomplished in the tables, and for which reason, in the values by ports, they will not agree with the publications of the Federal government, upon which they are based.

The tables follow:

Imports and Exports of New York between 1856 *and* 1897, *both nclusive, and the proportion of each and of both to the Total Imports and Exports of the United States.*

YEAR.	IMPORTS.		EXPORTS.		TOTAL.	
	Value.	Pr.ct.	Value.	Pr ct.	Value.	Pr.ct.
1856	$194,521,417	62.6	$78,942,489	28.0	$273,463,906	46.2
1857	216,108,452	62.9	80,294,227	27.4	297,002,679	44.7
1858	160,953,843	61.1	66,375,494	20.7	227,329,337	42.2
1859	216,616,902	65.3	59,638,985	20.3	276,329,337	44.2
1860	231,310,086	65.4	80,047,978	24.0	311,358,064	45.3
1861	188,790,086	65.2	126,675,185	57.6	315,465,271	62.0
1862	130,525,949	68.9	182,146,535	69.3	262,672,484	69.1
1863	175,522,885	72.1	141,894,809	69.5	307,669,420	68.7
1864	227,407,442	71.8	110,898,682	69.8	338,306,124	71.1
1865	152,248,978	68.6	116,818,548	73.6	269,067,524	64.0
1866	302,505,719	67.8	[illegible]28	48.60	472,096,847	59.4
1867	277,469,510	66.4	[illegible]30	45.96	412,835,240	57.9
1868	236,791,028	66.2	[illegible]30	46.0	366,729,558	56.9
1869	282,960,008	67.5	[illegible]88	48.6	406,969,410	57.8
1870	281,048,813	64.4	[illegible]79	40.7	440,968,492	53.2
1871	348,753,769	67.0	[illegible]52	45.2	549,286,621	57.0
1872	416,162,512	66.4	[illegible]50	46.5	622,738,462	58.1
1873	418,709,493	65.2	[illegible]87	45.5	656,654,880	56.3
1874	376,732,380	66.3	[illegible]84	47.8	654,550,914	56.7
1875	357,136,893	67.0	[illegible]35	45.6	692,769,228	56.6
1876	303,406,910	65.8	[illegible]38	43.1	590,818,746	53.6
1877	298,261,378	66.0	[illegible]81	43.7	561,722,509	53.3
1878	292,797,559	67.0	320,152,143	47.4	612,949,702	54.1
1879	302,349,053	67.8	335,733,509	47.1	638,082,562	55.1
1880	459,937,153	68.8	392,560,090	43.9	852,497,243	56.6
1881	435,450,905	67.7	407,181,024	46.1	842,641,929	54.6
1882	493,060,891	66.0	344,508,775	45.9	837,564,666	56.7
1883	496,005,276	68.6	361,425,361	43.8	857,430,637	55.4
1884	465,119,630	68.1	329,883,267	44.5	795,002,897	56.4
1885	380,077,748	65.8	344,514,761	46.5	724,592,509	54.9
1886	419,338,932	66.0	314,329,411	46.2	733,668,343	55.7
1887	456,698,631	65.9	316,347,219	44.1	773,045,850	54.8
1888	470,426,774	64.8	310,627,496	44.6	781,054,270	55.0
1889	472,153,507	63.3	319,385,555	42.0	791,992,062	53.6
1890	516,426,693	65.3	349,051,791	40.6	865,478,484	52.5
1891	537,786,007	63.6	346,528,847	39.0	884,314,854	51.1
1892	536,538,112	64.8	413,952,783	40.1	950,490,895	51.1
1893	548,558,593	63.3	347,957,717	41.2	896,516,310	52.3
1894	415,795,991	63.5	369,146,365	41.4	784,942,356	50.6
1895	477,741,128	65.2	325,580,062	40.3	803,321,190	52.1
1896	499,327,920	64.1	354,274,941	40.1	853,602,861	51.3
1897	480,603,590	62.7	391,679,907	37.2	872,283,498	46.0

Imports and Exports of Boston between 1856 *and* 1897, *both inclusive, and the proportion of each and of both to the Total Imports and Exports of the United States.*

YEAR.	IMPORTS.		EXPORTS.		TOTAL.	
	Value.	Pr.ct.	Value.	Pr.ct.	Value.	Pr.ct.
1856	$41,869,867	13.33	68	5 69	$57,256,435	9 69
1857	44,144,980	12.99	99	5.11	59,386,530	9.24
1858	38,035,104	14 44	96	5.72	53,818,790	10.06
1859	41 041,114	12.89	99	4.10	53,661,374	8 59
1860	39,333,684	11.12	94	3 62	52,661,478	7.57
1861	35,883,012	12.36	24	6.64	50,470,636	9.91
1862	22,106,451	11 07	97	6 69	34,872,648	9.17
1863	28,990,283	11.69	65	6 67	46,606,048	9.07
1864	30,189,931	9 54	00	6 07	49,960,231	8.61
1865	24,389,785	10 31	18	6.91	35,872,253	8.86
1866	42,659,684	9.57	94	3 34	64,761,678	6 98
1867	46,260,555	10 69	54	4 42	59,265,010	8.58
1868	38,942,341	10.32	04	4 46	49,520,705	7.74
1869	44,583,822	10.67	10,991,160	3.64	55,574,982	7.09
1870	47,484,060	10 91	12,012,965	3 66	59,497,026	7.17
1871	68,613,754	10 30	12,379,498	2.79	52	6.85
1872	70,275,066	11.21	20,540,778	4.62	39	8.48
1873	67,969,345	10 58	25,893,049	4 95	88	8.05
1874	52,659,729	9.17	27,686,285	4 68	64	6.91
1875	51,908,687	9.73	27,715,091	5 39	78	7.51
1876	37,272,890	8 08	33,047,636	6 11	26	7.01
1877	42,218,338	9.35	41,149,964	6.83	02	7.91
1878	40,268,023	9.21	46,960,591	6.75	14	7 70
1879	40,448,791	9.07	49,111,293	6.91	68	7.74
1880	68,503,136	10.25	59,237,831	7.05	67	8.48
1881	61,960,103	9.64	73,433,677	8 18	80	8 76
1882	69,594,057	9 40	62,471,426	8 31	83	8.95
1883	72,552 075	10.07	62,356,749	7 56	134,908,854	8 70
1884	65,865,551	9 87	63,497,839	8.57	129,363,380	9.17
1885	53,445,929	9.25	62,000,103	8 33	115,445,032	8.74
1886	58,430,707	9.19	54,099,505	7.97	112,530,212	8 65
1887	61,018,330	8.81	59,001,505	8.39	120,019,835	8.52
1888	63,897,778	8.80	56,457,384	8.11	120,345,162	8.47
1889	66,731,023	8 94	66,835,595	9 00	133,564.618	8 97
1890	62,876,666	7.96	71,202,944	8 03	134,079,610	8.14
1891	71,212,614	8.44	77,020,081	8.93	148,232,695	8 68
1892	71,780,489	8.09	87,175,636	8.36	158,956,125	8.65
1893	79,357,654	9.15	85,460,422	10 08	164,818,076	9.61
1894	50,309,331	7 67	83,972,460	9.40	134,281,791	8 67
1895	66,889,118	9.13	85,505,196	10 59	152,394,314	9 89
1896	79,179,864	10.16	95,851,004	12.29	175,030,868	10.52
1897	90,178,419	11.79	100,857,281	9.66	191,035,700	10.53

Imports and Exports of New Orleans between 1856 *and* 1897, *both inclusive, and the proportion of each and of both to the Total Imports and Exports of the United States.*

YEAR.	IMPORTS.		EXPORTS.		TOTAL.	
	Value.	Pr.ct.	Value.	Pr.ct.	Value.	Pr.ct.
1856	$14,906,765	4.59	$80,938,900	28.74	$95,844,665	16.86
1857	22,964,149	6.30	91,752,684	31.22	114,716,833	17.86
1858	15,065,178	5.72	88,874,986	32.67	103,940,164	19.30
1859	16,678,001	5.03	101,116,849	34.50	117,794,850	19.37
1860	20,636,316	5.80	108,164,712	33.40	128,801,028	18.74
1861	9,501,020	3.28	6,911,921	3.14	16,412,941	3.23
1862*	....	....	....	....	....	....
1863	[illegible]57	0.57	[illegible]60	[illegible]	5,809,717	1.27
1864	[illegible]09	0.45	[illegible]85	1.82	4,344,894	0.91
1865	[illegible]66	0.51	[illegible]28	0.66	2,569,258	0.48
1866	[illegible]20	1.95	[illegible]15	16.26	[illegible]85	8.10
1867	[illegible]49	2.66	[illegible]88	19.05	[illegible]32	13.46
1868	[illegible]97	3.60	[illegible]54	15.22	[illegible]51	8.87
1869	[illegible]00	2.65	[illegible]64	19.82	[illegible]54	9.49
1870	[illegible]71	3.29	[illegible]88	22.67	[illegible]59	12.48
1871	[illegible]96	3.54	[illegible]71	19.03	[illegible]67	10.[illegible]
1872	[illegible]25	2.94	[illegible]64	18.23	[illegible]39	9.28
1873	[illegible]01	3.09	[illegible]49	17.57	[illegible]50	9.59
1874	[illegible]48	2.54	[illegible]51	14.28	[illegible]99	9.38
1875	[illegible]22	2.31	[illegible]20	13.17	[illegible]42	7.64
1876	[illegible]72	2.45	[illegible]24	13.[illegible]	[illegible]96	8.55
1877	[illegible]86	2.96	[illegible]75	10.87	[illegible]81	7.10
1878	[illegible]12	2.49	[illegible]46	12.06	[illegible]58	8.96
1879	[illegible]31	1.06	[illegible]92	8.96	[illegible]13	6.11
1880	[illegible]58	1.61	[illegible]19	10.82	101,068,372	6.73
1881	[illegible]20	1.90	[illegible]66	11.49	115,957,966	7.50
1882	[illegible]91	1.67	[illegible]31	9.45	88,092,022	5.79
1883	[illegible]82	1.72	[illegible]14	10.31	104,904,976	6.77
1884	[illegible]01	1.01	[illegible]39	11.56	92,652,790	6.57
1885	[illegible]62	1.50	[illegible]74	10.67	87,697,126	6.86
1886	[illegible]71	1.37	[illegible]96	12.14	90,075,367	6.69
1887	[illegible]35	1.24	[illegible]09	11.16	88,172,944	6.26
1888	[illegible]49	1.60	[illegible]90	11.06	92,875,239	6.54
1889	[illegible]80	2.00	83,829,976	11.15	98,312,456	6.60
1890	[illegible]63	1.96	108,126,891	12.59	122,775,064	7.46
1891	[illegible]60	2.39	109,106,687	12.34	129,373,747	7.47
1892	[illegible]58	2.29	131,252,873	12.79	150,162,429	8.08
1893	[illegible]32	2.50	77,838,043	9.18	99,627,775	5.81
1894	[illegible]44	2.78	81,529,453	9.12	99,617,397	6.43
1895	[illegible]07	1.89	68,413,362	8.47	82,274,869	5.34
1896	[illegible]42	1.71	80,986,791	9.17	94,457,983	5.68
1897	[illegible]27	2.17	101,494,120	9.68	116,112,847	6.52

*No foreign commerce.

Imports and Exports of Baltimore between 1856 *and* 1897, *both inclusive, and the proportion of each and of both to the Total Imports and Exports of the United States.*

YEAR.	IMPORTS.		EXPORTS.		TOTAL.	
	Value.	Pr.ct.	Value.	Pr.ct.	Value.	Pr.ct.
1856	07	2.98	06	3.20	05	2.40
1857	08	3.08	35	4.08	48	3.77
1858	97	3.36	19	3.76	17	3.50
1859	51	2.06	06	2.71	67	2.12
1860	05	2.76	00	2.80	05	2.72
1861	98	3.25	08	6.02	61	4.55
1862	83	1.90	74	4.38	56	3.17
1863	88	1.89	16	4.53	19	3.07
1864	41	1.81	39	4.16	70	2.62
1865	54	2.001	74	3.95	28	2.61
1866	01	1.83	28	1.84	14	1.59
1867	09	2.92	64	2.38	73	2.76
1868	49	[illegible]	06	3.02	42	3.61
1869	32	3.79	19	3.61	51	3.56
1870	68	4.47	00	3.06	66	3.87
1871	71	4.74	53	3.05	94	3 90
1872	06	4.60	34	3.76	90	4.25
1873	44	4 55	13	3.26	57	3.97
1874	94	5 16	90	4.24	84	4.69
1875	61	5 21	79	4.06	60	5.03
1876	46	4.33	34	4.82	70	4.98
1877	44	4.94	07	6.04	61	5.57
1878	56	3.86	18	6.42	73	5.43
1879	04	3.14	16	8.08	20	6.19
1880	89	2.86	66	9.13	[illegible],55	6.30
1881	16	2.51	09	8.08	88,661,509	5 73
1882	58	[illegible]	26	5.24	54,366,494	3.63
1883	79	2.01	51	6.79	69,602,530	[illegible]
1884	85	1.71	94	5 81	64,502,969	3.87
1885	96	2.05	04	6 07	56,902,660	4.31
1886	44	1.84	[illegible].89	5.27	47,544,722	3.61
1887	29	1.89	51,607,149	7.20	64,143,069	4.56
1888	85	1.61	46,230,727	6 62	57,878,312	4.06
1889	44	2.01	50,611,662	6.80	65,635,506	4.42
1890	03	1.66	78,969,698	8.61	87,128,895	5.29
1891	87	2.43	64,412,247	7.26	84,967,934	4.91
1892	23	1.62	96,860,197	9.59	112,268,720	6.00
1893	45	1.85	71,506,995	8.43	87,657,941	5.11
1894	00	1.81	78,422,129	8.79	90,401,029	5.84
1895	95	1.67	61,938,905	7.67	74,190,611	4.51
1896	30	1.72	66,398,905	7.52	79,866,535	4.80
1897	99	1.48	86,926,510	8 15	97,297,708	5.36

Imports and Exports of Philadelphia between 1856 *and* 1897, *both inclusive, and the proportion of each and of both to the Total Imports and Exports of the United States.*

YEAR.	IMPORTS.		EXPORTS.		TOTAL.	
	Value.	Pr.ct.	Value.	Pr ct.	Value.	Pr.ct.
1856	$16,570,447	5.33	186	2.47	127	3.97
1857	17,884,042	5.11	13	2.37	55	3.70
1858	12,775,591	4.85	69	2.14	60	3.47
1859	040	4.37	55	1.69	95	3.14
1860	34	4.72	67	1.85	01	2.98
1861	80	4.56	58	4.56	28	4.42
1862	82	3.06	42	5.19	24	4.29
1863	20	3.00	99	4.46	19	3.66
1864	36	2 90	03	4.06	30	3.20
1865	76	2 50	40	3.53	16	3.90
1866	36	2.95	29	2.90	05	3.02
1867	80	3 07	48	3.83	28	3.28
1868	05	4.04	51	3.07	56	3.80
1869	88	3 76	16	3.76	04	3.78
1870	11	3.30	64	2.56	75	2.96
1871	95	3.07	01	3.60	96	3.31
1872	32	3.25	03	4 25	26	3.66
1873	61	3 95	43	4.06	04	4.00
1874	37	4.69	51	5.00	88	4 86
1875	33	4.52	95	4.94	18	4.73
1876	67	4 96	97	6.59	84	5.79
1877	74	4.35	88	7 11	62,515,702	5.93
1878	96	4.65	53	6.28	62,934,049	5.54
1879	71	5.46	40	6.61	71,876,511	6 17
1880	00	5.45	92	5.94	85,594,193	5.69
1881	04	5.07	05	4.90	96,812,511	6.26
1882	79	6.07	66	6.08	72,267,837	4.91
1883	56	4.65	44	4.62	72,986,200	4.71
1884	16	5.04	69	4.92	70,140,784	4.98
1885	19	5.04	61	5.10	66,642,290	5.20
1886	18	5.75	17	4.90	70,814,030	5.33
1887	49	5.77	56	4.94	06	5.35
1888	21	5.75	61	4.14	83	4.97
1889	02	6.61	11	4.01	13	5.26
1890	15	6.83	83	4.24	06	5.60
1891	80	7.03	55	3.80	45	5.30
1892	81	7.25	57	4.49	48	6.30
1893	67	7.68	82	5.82	29	6.74
1894	53	8 22	96	4 53	49	6.09
1895	56	5.62	93	4.33	83,845,769	5.44
1896	36	5 62	76	4.48	83,406,213	5.01
1897	72	6 28	73	4.49	95,377,945	5.24

Imports and Exports of Galveston, between 1856 *and* 1897, *both inclusive, and the proportion of each and both to the Total Imports and Exports of the United States.*

YEAR.	IMPORTS.		EXPORTS.		TOTAL.	
	Value.	Pr.ct.	Value.	Pr.ct.	Value.	Pr.ct.
1856	$92,259	0.02	$1,252,925	0.44	$1,345,184	0.24
1857	271,936	0.06	1,491,375	0.50	1,763,311	0.27
1858	71,381	0.02	2,428,465	0.89	2,499,846	0.46
1859	378,967	0.11	3,838,769	1.31	4,217,736	0.67
1860	533,153	0.12	5,772,158	1.73	6,305,311	0.92
1861	175,222	0.06	1,121,292	0.51	1,296,514	0.25
1862*	....	......	....	......	....	......
1863*	....	......	....	......	....	......
1864*	....	......	....	......	....	......
1865*	....	......	....	......	....	......
1866	111,357	0.03	789,991	0.21	901,348	0.11
1867	571,757	0.13	5,100,039	1.61	5,671,796	0.82
1868	579,996	0.16	4,238,181	1.58	4,817,177	0.77
1869	266,517	0.06	7,156,447	2.50	7,422,964	1.06
1870	509,231	0.11	12,306,490	3.13	12,815,721	1.54
1871	1,255,003	0.24	12,355,977	2.70	13,610,980	1.41
1872	1,741,000	0.27	10,983,266	2.47	12,724,266	1.18
1873	2,426,626	0.30	13,826,885	2.64	16,253,511	1.39
1874	1,419,955	0.25	17,262,165	2.90	18,682,120	1.62
1875	1,216,265	0.22	14,303,862	2.78	15,520,127	1.46
1876	1,332,940	0.28	13,599,468	2.51	14,932,808	1.48
1877	1,411,594	0.31	14,202,285	2.36	15,613,879	1.48
1878	1,078,368	0.24	11,985,327	1.71	13,063,695	1.15
1879	856,089	0.19	16,425,164	2.29	17,281,253	1.49
1880	1,004,514	0.15	16,749,887	2.01	17,754,403	1.18
1881	3,101,324	0.45	26,767,107	2.96	29,868,431	1.93
1882	3,022,274	0.41	15,523,388	2.06	18,545,662	1.21
1883	1,511,712	0.209	29,629,047	3.59	31,140,759	2.01
1884	1,119,708	0.16	20,454,948	2.76	21,574,656	1.58
1885	1,157,370	0.20	12,679,154	1.69	13,836,524	1.04
1886	757,133	0.110	16,966,851	2.06	17,723,984	1.34
1887	705,309	0.10	18,902,898	2.63	19,608,107	1.39
1888	715,868	0.09	15,703,147	2.26	16,419,015	1.15
1889	722,056	0.09	15,756,192	2.12	[illegible]48	1.10
1890	415,792	0.05	24,446,831	2.84	[illegible]23	1.60
1891	648,821	0.07	33,772,005	3.08	[illegible]26	1.60
1892	1,317,000	0.15	35,336,256	3.42	[illegible]56	1.97
1893	863,452	0.09	37,476,494	4.42	[illegible]46	2.29
1894	860,717	0.10	35,011,768	3.92	[illegible]05	2.30
1895	389,575	0.05	41,636,651	5.18	[illegible]26	2.74
1896	602,770	0.07	26,897,091	4.12	[illegible]61	2.23
1897	779,995	0.10	58,108,174	5.53	[illegible]33	3.34

* None.

Table showing the Total Imports and Exports of the United States, separately, and the Total Imports and Exports together, from 1856 *to* 1897, *inclusive.*

YEAR.	Imports.	Exports.	Imports and exports.
1856	16	23	$691,649,783
1857	42	60	641,252,152
1858	54	74	535,349,928
1859	61	51	624,185,392
1860	19	57	687,193,176
1861	42	38	506,864,375
1862	77	91	380,027,278
1863	15	47	447,300,262
1864	32	88	475,285,271
1865	30	08	404,774,882
1866	58	23	794,871,690
1867	71	41	712,337,712
1868	40	89	639,389,339
1869	79	97	703,624,076
1870	36	58	828,730,176
1871	34	78	963,043,862
1872	77	97	1,070,772,663
1873	10	23	1,164,616,132
1874	[illegible]	40	1,153,689,382
1875	96	11	1,046,448,147
1876	30	71	1,001,125,861
1877	36	20	1,053,689,863
1878	92	66	1,131,917,298
1879	75	41	1,156,217,216
1880	46	58	1,503,592,304
1881	26	46	1,545,041,974
1882	74	57	1,475,181,831
1883	14	92	1,547,020,316
1884	33	09	1,408,211,302
1885	30	55	1,319,717,084
1886	56	90	1,315,960,866
1887	38	11	1,408,502,979
1888	14	05	1,419,911,621
1889	52	75	1,487,533,027
1890	00	84	1,647,139,093
1891	96	10	1,729,397,006
1892	72	48	1,857,680,612
1893	72	94	1,714,066,116
1894	22	72	1,547,135,194
1895	65	65	1,539,508,130
1896	74	38	1,662,331,612
1897	80	53	1,815,704,862

Table showing New York's percentage of the Imports and Exports of the United States, in periods of one year, four years and ten years, from 1858 *to* 1897, *both inclusive.*

YEAR.	IMPORTS. PERIODS.			EXPORTS. PERIODS.			TOTAL. PERIODS.			Year.
	1-yr.	4-yrs.	10-yrs.	1-yr.	4-yrs.	10 yrs.	1-yr.	4-yrs.	10-yrs.	
1858	61.1			28.0			46.2			1858
1859	65.3			20.3			44.2			
1860	65.4			24.0			45.3			
1861	65.2	64.25		57.6	32.72		62.0	32.72		
1862	68.9			69.3			69.1			
1863	72 1			69 5			68.7			
1864	71.8			69.8			71.1			
1865	68.6	69.10		78.6	70.55		64.0	68.22		
1866	67.8			48.6			59.4			
1867	66.4		66.76	45.9		50.66	57.9		58.79	1867
1868	66.2			46.0			58.9			
1869	67.5	66.97		43.6	46.02		57.8	58.50		
1870	64.4			40.7			58.2			
1871	67.0			45.2			57.0			
1872	66.4			46.5			58.1			
1873	65.2	65.75		45.5	44.47		56.8	56.15		
1874	66.3			47.3			56.7			
1875	67.0			45.6			56.6			
1876	65.8			43.1			53.6			
1877	66.0	66.27	66.18	43.7	44.92	44.72	53.8	55.05	56.15	1877
1878	67.0			47.4			54.1			
1879	67.8			47.1			55.1			
1880	68.8			43.9			56.6			
1881	67.7	67.82		45.1	45.87		54.6	55.10		
1882	68.0			45.9			56.7			
1883	68.6			43.8			55.4			
1884	68.1			44.5			56.4			
1885	65.8	67.62		46.5	45.17		54.9	55.85		
1886	66.0			46.2			55.7			
1887	65.9		67.37	44.1		45.45	54.8		55.43	1887
1888	64.8			44.6			55.0			
1889	63.3	65.00		48.0	44.47		53.6	54.77		
1890	65.3			40.6			52.5			
1891	63.6			39.0			51.1			
1892	64.8			40.1			51.1			
1893	63.3	64.25		41.2	40.22		52.3	51.75		
1894	63.5			41.4			50.6			
1895	65.2			40.3			52.1			
1896	64.1			40.1			51.3			
1897	62.7	63.87	64.06	37 2	39.75	40.75	48.0	50.50	51.76	

Table showing Boston's percentage of the Imports and Exports of the United States, in periods of one year, four years and ten years, from 1858 *to* 1897, *both inclusive:*

YEAR.	IMPORTS.			EXPORTS.			TOTAL.			Year.
	PERIODS.			PERIODS.			PERIODS.			
	1-yr.	4-yrs.	10-yrs	1-yr.	4-yrs.	10-yrs.	1-yr.	4 yrs.	10 yrs.	
1858	14.44			5.72			10.05			
1859	12.38			4.10			8 50			
1860	11.12			3.82			7.57			
1861	12.36	12 57		6.64	5.07		9.91	9.01		
1862	11.67			6.69			9 17			
1863	11.09			6 67			9.07			
1864	9.54			6 07			8.61			
1865	10.21	10.63		6.91	6.58		8 85	8 93		
1866	9.57			3.34			6.98			
1867	10.83		11.32	4.42		5.44	8.58		8.73	1867
1868	10.33			4.46			7.74			
1869	10.67	10 35		3.84	4.01		7.89	7.80		
1870	10 91			3.05			7.17			
1871	10.86			2.79			6.85			
1872	11.21			4.62			8.48			
1873	10.58	10.75		4.95	3.60		8.05	7.64		
1874	9.17			4.68			6.91			
1875	9 73			5.39			7.51			
1876	8.08			6.11			7.01			
1877	9.85	9.08	10.63	6.83	5.75	4.67	7.91	7.58	7.55	1877
1878	9.21			6.75			7.70			
1879	9 07			6.91			7.74			
1880	10.25			7.08			8.48			
1881	9 64	9 54		8.13	7.22		8 76	8.17		
1882	9.60			8.32			8.95			
1883	10.07			7.56			8.70			
1884	9.87			8.57			9 17			
1885	9.25	9.69		8.33	8.19		8.74	8.89		
1886	9.19			7.97			8 55			
1887	8 81		9.49	8.39		7.80	8.52		8.58	1887
1888	8.80			8.11			8.47			
1889	8.94	8.93		9.00	8.37		8.97	8.63		
1890	7.96			8.03			8.14			
1891	8.44			8.93			8.58			
1892	8.69			8.36			8.55			
1893	9.15	8.56		10.08	8.85		9.61	8.72		
1894	7.67			9.40			8 57			
1895	9.13			10.59			9.89			
1896	10.16			12.29			10.52			
1897	11.79	9.69	9.07	9.60	10.47	9.44	10.52	9.90	9.19	1897

Table showing New Orleans' percentage of the Imports and Exports of the United States, in periods of one year, four years and ten years, from 1858 to 1897, both inclusive:

YEAR	IMPORTS			EXPORTS			TOTAL.			Year.
	PERIODS.			PERIODS.			PERIODS.			
	1-yr.	4-yrs.	10-yrs.	1-yr.	4-yrs.	10-yrs.	1-yr.	4-yrs.	10 yrs.	
1858	5.72			32.67			19.39			
1859	5.03			34.50			18.87			
1860	5.80			32.40			18.74			
1861	3.28	4.96		3.14	25.68		3.22	15.05		
1862 *										
1863	0.57			2.16			1.27			
1864	0.45			1.82			0.91			
1865	0.51	0.51		0.06	1.88		0.63	0.94		
1866	1.95			15.28			8.19			
1867	2.66		2.88	19.05		15.62	13.46		9.41	1867
1868	3.60			15.22			8.37			
1869	2.65	2.56		19.82	17.34		9.49	9.88		
1870	3.29			22.67			12.48			
1871	3.54			19.03			10.68			
1872	2.94			18.22			9.28			
1873	3.09	3.71		17.57	19.37		9.50	10.51		
1874	2.54			14.28			9.38			
1875	2.31			13.17			7.64			
1876	2.45			13.76			8.55			
1877	2.06	2.34	2.78	10.87	10.83	18.46	7.10	7.17	9.25	1877
1878	2.49			12.05			8.36			
1879	1.05			8.96			6.11			
1880	1.61			10.82			6.72			
1881	1.90	1.76		11.49	10.83		7.50	7.17		
1882	1.67			9.45			5.70			
1883	1.32			10.31			6.77			
1884	1.61			11.55			6.57			
1885	1.50	1.52		10.67	10.49		6.88	6.48		
1886	1.27			12.14			6.89			
1887	1.24		1.56	11.16		10.86	6.26		6.77	1887
1888	1.60			11.66			6.54			
1889	2.00	1.53		11.15	11.53		6.60	6.57		
1890	1.96			12.59			7.46			
1891	2.39			12.34			7.47			
1892	2.29			12.79			8.08			
1893	2.50	2.28		9.18	11.72		5.81	7.20		
1894	2.73			9.13			6.43			
1895	1.89			8.47			5.34			
1896	1.71			9.17			5.68			
1897	2.17	2.12	2.12	9.68	9.11	10.61	6.52	5.90	6.59	1897

*No foreign commerce.

Table showing Baltimore's percentage of the Imports and Exports of the United States, in periods of one year, four years and ten years, from 1858 *to* 1897, *both inclusive.*

YEAR.	IMPORTS.			EXPORTS.			TOTAL.			Year.
	PERIODS.			PERIODS.			PERIODS.			
	1-yr.	4-yrs.	10-yrs.	1-yr.	4-yrs.	10-yrs.	1-yr.	4-yrs.	10-yrs.	
1858........	3.38			3.30			3.40			
1859........	2.93			2.71			3.12			
1860........	2.76			2.50			2.72			
1861........	3.25	3.08		6.02	3.75		4.55	3.49		
1862........	1.90			4.38			3.17			
1863........	1.80			4.53			3.07			
1864........	1.81			4.16			2.62			
1865........	2.00	1.88		3.95	4.25		2.81	2.92		
1866........	1.83			1.84			1.89			
1867........	2.92		2.46	2.23		3.60	2.76		3.08	1867
1868........	3.61			3.62			3.61			
1869........	3.70	3.04		3.61	2.82		3.58	2.96		
1870........	4.47			3.06			3.87			
1871........	4.74			3.05			3.96			
1872........	4.60			3.76			4.25			
1873........	4.55	4.84		3.26	3.28		3.97	4.01		
1874........	5.16			4.24			4.69			
1875........	5.21			4.66			5.03			
1876........	4.83			4.82			4.93			
1877........	4.94	5.03	4.59	6.04	4.94	4.01	5.43	5.05	4.84	1877
1878........	3.86			6.42			5.43			
1879........	3.14			8.08			6.19			
1880........	2.98			9.18			6.39			
1881........	2.51	3.12		8.03	7.91		5.73	5.93		
1882........	2.06			5.24			3.68			
1883........	2.01			6.79			4.49			
1884........	1.71			5.81			3.87			
1885........	2.05	1.96		6.07	5.98		4.31	4.09		
1886........	1.84			5.27			3.61			
1887........	1.83		2.40	7.20		6.80	4.55		4.82	1887
1888........	1.61			6.62			4.08			
1889........	2.01	1.82		6.80	6.47		4.42	4.16		
1890........	1.66			8.61			5.28			
1891........	2.43			7.28			4.91			
1892........	1.62			9.59			6.00			
1893........	1.85	1.89		8.43	8.48		5.11	5.32		
1894........	1.81			8.79			5.84			
1895........	1.67			7.67			4.81			
1896........	1.72			7.52			4.80			
1897........	1.48	1.67	1.78	8.15	8.03	7.94	5.35	5.94	5.35	

Table showing Philadelphia's percentage of Imports and Exports of the United States, in periods of one year, four years and ten years, from 1858 *to* 1897, *both inclusive.*

YEAR.	IMPORTS.			EXPORTS.			TOTAL.			Year.
	PERIODS.			PERIODS.			PERIODS.			
	1-yr.	4-yr.	10-yr.	1-yr.	4-yr.	10-yr.	1-yr.	4-yr.	10-yr.	
1858	4.85			2.47			3.97			1858
1859	4.37			1.69			3.14			
1860	4.13			1.85			2.98			
1861	4.36	4.43		4.56	2.43		4.42	3.49		
1862	3.06			5.19			4.39			
1863	3.00			4.46			3.66			
1864	2.80			4.05			3.26			
1865	2.50	3.84		3.58	4.31		3.90	3.30		
1866	2.95			2.90			3.02			
1867	3.67		3.57	3.83		3.37	3.98		3.61	1867
1868	4.04			3.07			3.89			
1869	3.78	3.81		3.76	3.38		3.78	3.67		
1870	3.30			2.56			2.96			
1871	3.07			3.60			3.31			
1872	3.25			4.25			3.66			
1873	3.95	3.39		4.66	3.62		4.00	3.48		
1874	4.69			5.00			4.36			
1875	4.52			4.94			4.73			
1876	4.86			6.59			5.79			
1877	4.35	4.60	3.98	7.11	5.91	4.49	5.93	5.33	4.29	1877
1878	4.65			6.28			5.56			
1879	5.46			6.61			6.17			
1880	5.46			5.94			5.68			
1881	5.07	5.16		4.90	5.98		6.26	5.92		
1882	5.07			5.08			4.91			
1883	4.65			4.62			4.71			
1884	5.04			4.92			4.98			
1885	5.04	4.95		5.19	4.95		5.20	4.95		
1886	5.75			4.99			5.33			
1887	5.77		5.19	4.95		5.34	5.35		5.41	1887
1888	5.75			4.14			4.97			
1889	6.51	5.69		4.01	4.52		5.26	5.23		
1890	6.83			4.24			5.60			
1891	7.03			3.80			5.38			
1892	7.25			4.49			6.38			
1893	7.63	7.18		5.82	4.59		6.74	6.02		
1894	8.22			4.53			6.09			
1895	5.62			4.33			5.44			
1896	5.62			4.48			5.01			
1897	6.28	6.43	6.67	4.49	4.46	4.43	5.24	5.44	5.61	1897

Table showing Galveston's percentage of Imports and Exports of the United States, in periods of one year, four years and ten years, from 1858 *to* 1897, *both inclusive.*

YEAR.	IMPORTS.			EXPORTS.			TOTAL.			Year.
	PERIODS.			PERIODS.			PERIODS.			
	1-yr.	4-yr.	10-yr.	1-yr.	4-yr.	10-yr.	1-yr.	4-yr.	10-yr.	
1858	0.02			0.89			0.46			1858
1859	0.11			1.31			0.67			
1860	0.12			1.73			0.92			
1861	0.06	0.08		0.51	1.11		0.25	0.57		
1862 *										
1863 *										
1864 *										
1865 *										
1866	0.03			0.21			0.11			
1867	0.13		0.06	1.61		1.04	0.82		0.54	1867
1868	0.16			1.53			0.77			
1869	0.06	0.09		2.50	1.46		1.05	0.69		
1870	0.11			3.13			1.54			
1871	0.24			2.79			1.41			
1872	0.27			2.47			1.18			
1873	0.30	0.23		2.64	2.76		1.89	1.38		
1874	0.25			2.90			1.62			
1875	0.22			2.78			1.48			
1876	0.28			2.51			1.48			
1877	0.31	0.28	0.22	2.85	2.63	2.56	1.48	1.51	1.34	1877
1878	0.24			1.71			1.15			
1879	0.19			2.39			1.49			
1880	0.15			2.01			1.18			
1881	0.48	0.26		2.96	2.27		1.93	1.44		
1882	0.41			2.06			1.21			
1883	0.209			3.59			2.01			
1884	0.16			2.76			1.53			
1885	0.20	0.24		1.69	2.52		1.04	1.45		
1886	0.119			2.05			1.34			
1887	0.10		0.24	2.63		2.38	1.39		1.42	1857
1888	0.09			2.26			1.15			
1889	0.09	0.10		2.12	2.26		1.10	1.24		
1890	0.05			2.84			1.50			
1891	0.07			3.08			1.99			
1892	0.15			3.43			1.97			
1893	0.09	0.09		4.42	3.44		2.23	1.92		
1894	0.10			3.92			2.74			
1895	0.05			5.18			2.74			
1896	0.07			4.12			2.22			
1897	0.10	0.08	0.086	5.52	4.95	3.79	3.24	3.10	3.24	1897

* None.

A glance at the Boston tables will be profitable. During the four years of the civil war, there was a slight decrease in the percentage of Boston's foreign commerce. The percentage of Boston's foreign commerce was never greater than last year—New York's has not been so low in thirty-eight years, as it was last year. During the civil war the loss in Boston's imports was almost made good by the increase in exports.

In Philadelphia there was a loss of imports, but a gain in exports, during the four years of the civil war, sufficient to increase the average of the port's foreign commerce 0.31 per cent. more than it was during the four years preceding the civil war.

For ready comparison, and for some reflections thereon, the following three brief tables are appended, which epitomize the growth and decline of foreign commerce in the ports named since 1856:

Table showing percentage of the nation's total imports in averages for ten year periods, from 1858 *to* 1897, *both inclusive:*

Average per cent during 10 years ending in:	New York.	Boston.	New Orleans.	Philadelphia.	Baltimore.	Galveston.
1867	66.76	11.32	2.88	3.57	2.46	0.06
1877	66.18	10.03	2.78	3.98	4.59	0.22
1887	67.37	9.49	1.56	5.19	2.40	0.24
1897	64.06	9.07	2.12	6.67	1.78	0.86
THE SAME ON EXPORTS.						
1867	50.66	5.44	15.62	3.37	3.60	1.04
1877	44.72	4.67	18.46	4.49	4.01	2.56
1887	45.45	7.80	10.86	5.34	6.80	2.38
1897	40.75	9.44	10.61	4.43	7.94	3.79
THE SAME ON BOTH IMPORTS AND EXPORTS.						
1867	58.79	8.73	9.41	3.61	3.03	0.54
1877	56.15	7.55	9.25	4.29	4.34	1.34
1887	55.43	8.53	6.77	5.41	4.82	1.42
1897	51.76	9.19	6.59	5.61	5.35	2.23

New York is the only Atlantic coast port showing a decline in percentage of both imports and exports.

New York's decline in percentage of exports is 9.09 per cent.

Boston's gain in percentage of exports is 4 per cent.

Philadelphia's imports have almost doubled.

During the past ten years New York's loss of imports has been as great as Philadelphia's gain in forty years.

During the past two years New York's decline in percentage of imports and exports has been almost three times as great as the gain has been in the three other leading Atlantic ports.

While New Orleans shows a loss of 0.18 per cent. in the percentage of its imports and exports, since 1887, New York's loss during the same time was 3.67 per cent. The other four leading ports show a gain.

The gain in the foreign commerce (in percentage of the whole) of the ports of Boston, Philadelphia, Baltimore and Galveston, since 1867, does not equal the loss sustained by the port of New York during the same period.

It is a significant fact that there was no abnormal increase in the commerce of Boston, Philadelphia or Baltimore, during the four years of the civil war. In Boston there was a decline from the four years preceding the war of 0.08 of 1 per cent.; in Philadelphia the increase during the civil war was but 0.31 of 1 per cent.; while in Baltimore there was a decline of 0.57 of 1 per cent., a net loss in the three ports of 0.34 of 1 per cent., while in the port of New York the percentage of increase was more than one-third of the nation's total, being 35.50 per cent., showing that the natural facilities of the port of New York, in any emergency, are far superior to those of any other, and are availed of, regardless of the inconveniences or losses.

New York has been slowly losing the position and prestige she gained during the civil war. New Orleans finds the struggle more and more difficult, despite the energies put forth, to regain that which was lost, and win back her old-time prestige. But it will come to her yet.

New York must learn the lesson of New Orleans' losses, and the difficulties that a port experiences in regaining that which has once been lost in the line of commerce. It is easy to lose, but hard to regain. We might far better exert ourselves to see that we lose no more, than to attempt, at this critical time, perhaps, the stupendous task of regaining that which we have lost.

It is more than disquieting to look back to 1880 in the tables and to note that when the total imports and exports of the United States were more than $300,000,000 less than they were in 1897, they were only $20,000,000 less in New York than in 1897; that is to say, while in that period the nation's foreign commerce has increased $300,000,000, New York's has increased but $20,000,000. Since 1880 Boston's foreign commerce has increased over $63,000,000, New Orleans has increased nearly $17,000,000 and Galveston's has increased over $41,000,000 — in fact has increased more than three-fold.

These are facts, surely, that cannot mislead us. They point their own moral. They tell their own story.

In 1892 the total value of the imports and exports of the United States was $1,857,680,612, the highest in the country's history. That year New York's share was $950,490,895. In 1897 there was a falling off in the nation's total foreign commerce from 1892 of $31,975,750, but the loss New York sustained during the same period was $78,207,393, that is to say, it fell from 51.1 per cent.

of the nation's total foreign commerce, in 1892, to 48 per cent. in 1897 — the lowest proportion of the nation's foreign commerce seen in New York since before the civil war.

In forty years the foreign commerce of the nation has increased three-fold. If it shall increase three-fold during the next forty years, it will have largely exceeded five billions of dollars in value, and if New York is but able to retain one-half of it, her foreign commerce would be more than two and a half billions of dollars in value — three times as large as at present. But New York will not retain her present proportion if she does nothing to attract commerce to her, or if she does everything to drive it to other ports.

During the years to come the development of American markets abroad will probably be much more to the southward than to the eastward, and, perhaps, much more to the westward than either to the eastward and southward. The development in manufacturing, in the South, will be accelerated, and that section will make the contest all the more difficult for New York. Easier and nearer access both to the South and the West, the latter through the Nicaragua or the Panama canals, or both, perhaps, it will be extremely difficult for New York to hold her own in the commercial and the industrial struggle there is ahead.

If the old-time virility and energy and shrewdness still exists among the people of New York, city and State — if that commercial acumen that has been inherited and developed during a century of remarkable growth is brought into play — the possibility of a keener contest, and of increasing difficulties in holding fast to her commercial supremacy will not dishearten, but will inspire them to face the new issues and conditions of the future unflinch-

ingly, determined to leave nothing undone that shall keep New York where she now is, at least.

But there must be a revolution in the methods of handling commerce in the port of New York. Charges must be abated, even if the State be compelled to step in and acquire properties that now accommodate and attend upon commerce. The fact that much more than a hundred millions of dollars has been invested in New York's canals for the benefit of commerce and the cheapening of transportation, is justification for any step that the State may take to fully utilize those canals and unfetter the commerce, at terminals, that seeks passageway through the State by any route of transportation.

It should not be forgotten that forces are steadily at work, with a policy and a purpose well and clearly defined, to bring the great trunk railroads paralleling the canals and centering at the port of New York under one single individual control. What the Joint Traffic Association may not do, the dominating influence which controls these railroads may then do. It is more than ever essential to New York, commercially and industrially, that her canals shall be steadily improved, both in the prisms, in the locks and at the terminals. The freest opportunity must be given to industrial and commercial expansion — only possible through cheap transportation, and attainable nowhere else like it is attainable through the canals and natural streams of the State. Every restriction upon commerce and canal transportation companies that now exists in our laws must be removed. And these must be supplemented by judicious, but, if necessary, severe enactments that will prevent any combination, however powerful, from in any degree impairing the usefulness or minimizing the attractiveness

or the accommodations of New York's canals and their great terminals.

After pressing these essential reforms to a successful consummation, other obstacles and difficulties will unquestionably arise that must be resolutely and fearlessly overcome. To safeguard New York's great commercial interests, they must be constantly under the supervision of vigilant officials, clothed with all needful power and backed up by strong public sentiment, to at once root out abuses and at all times broaden the pathway of commerce, so that never again may it be said that the great State of New York is neglecting her industries, her transportation routes or her commerce, the healthy and active condition of which are the prime essentials to a substantial, reliable and permanent prosperity and contentment among all of the people of the State.

CANAL IMPROVEMENT WORK.

The improvement work now in progress on the Erie, Oswego and Champlain canals has reached what appears to be a critical point, because the appropriation of $9,000,000, which was voted for this work, is now found to be inadequate.

Without attempting to ascertain the facts, but actuated solely by political motives and an unquenchable thirst for sensational news, a portion of our public prints have recently seen fit to make many unwarranted attacks, not only on the officials charged with the conduct of this work, but on the character of the work done, and in fact doing their utmost to prevent the completion of this great work, which unquestionably means so much to our welfare.

The work shows for itself, and every feature of it will bear the fullest investigation. The effort to discredit it is but another instance of commercial blindness and stupid political dishonesty.

A diagram is herewith submitted to show the location of each and every contract that has been or will have to be awarded on each of these three canals, in order to complete the work as now authorized. The following tables explain the estimated cost of all of these contracts. Tables 1, 2 and 3, and the recapitulation are up to date. Tables 4, 5 and 6 show expenditures to the end of the fiscal year 1897, as covered by this report:

TABLE I.

CANAL IMPROVEMENT.

Showing the relative amounts of the engineer's estimates, the estimates at contract prices, and the final estimates for each contract on each canal.

Con. Nos.	Eastern Division. Engineer's estimate. Erie.	Eastern Division. Engineer's estimate. Champlain.	Eastern Division. Estimate at contract prices.	Eastern Division. Final estimate.	Middle Division. Engineer's estimate. Erie.	Middle Division. Engineer's estimate. Oswego.	Middle Division. Estimate at contract prices.	Middle Division. Final estimate.	Western Division. Eng's est. Erie.	Western Division. Estimate at contract prices.	Western Division. Final estimate.
1	*$175,357	...	...	...	$136,468	...	$125,520	...	$433,225	$394,955	...
2	57,688	...	$52,910	...	185,078	...	148,949	...	287,834	291,686	...
3	75,028	...	74,159	...	127,781	...	136,842	...	312,510	188,542	...
4	33,251	...	31,590	...	138,932	...	154,471	...	10,287	8,545	$11,097
5	90,533	...	88,434	...	141,444	...	150,615	...	227,102	217,120	...
6	45,080	...	43,831	...	...	$14,497	12,206	...	166,090	165,800	...
7	129,264	...	113,437	$141,591	...	12,618	10,695	...	99,725	98,760	...
8	...	$66,270	58,376	89,940	...	15,333	13,426	...	191,090	184,095	...
9	...	98,300	92,296	116,634	...	20,049	17,801	...	114,440	111,000	...
10	...	245,189	214,317	...	...	48,058	51,370	...	152,090	135,500	...
11	116,396	...	96,304	118,240	...	36,571	30,345	$32,182	116,835	110,100	...
12	84,740	...	79,321	...	16,482	...	16,195	18,751	96,540	87,000	...
13	41,860	...	38,749	45,315	16,194	...	15,352	...	119,727	105,850	...
14	*289,626	...	...	...	16,447	...	15,357	17,867	169,830	159,695	...
15	9,677	...	9,122	...	...	66,144	62,191	...	90,915	88,595	...
16	225,335	...	181,998	...	...	67,500	73,925	100,075	*499,000	...	...
17	71,073	...	65,812	...	11,236	...	8,893	9,402	125,557	...	...
18	91,905	...	97,301	...	96,373	...	91,795	...	61,135	...	...
19	149,280	...	132,678	...	106,322	...	105,054	...	94,916	...	...
20	*143,225	...	...	...	246,653	...	242,758	...	98,105	...	...
21	*69,895	...	...	...	218,247	...	212,945	...	66,438	...	...
22	*83,345	...	...	...	247,465	...	232,307	...	*128,334	...	...
23	68,208	...	53,000	...	165,897	...	147,582	...	25,620	...	...
24	74,450	...	59,290	...	142,051	...	136,720	...	140,000	...	...

25	*212,845				140,680		127,750		†200,000		
26	*22,334				140,452		136,600		†144,290		
27	94,489		69,829		125,869		115,713		†30,000		
28		85,570	64,250		172,430		167,216				
29		38,294	34,017			†75,370					
30		30,897	26,087			†120,000					
31		37,994	33,748			†20,000					
32		†90,000				†235,000					
33		†120,000				†20,000					
34		†345,000				136,885	126,655				
35		†25,000				†35,000					
36		†45,000				51,057	48,447				
37		†50,000				13,836	15,382				
38		†85,000				†125,000					
39		†260,000				†35,000					
40	97,520					†106,000					
41	101,085					†35,000					
42		†376,560				†35,000					
43	†120,500					†35,000					
44	144,500					†35,000					
45	96,000					†35,000					
46	82,000					16,860	12,636				
47	143,000					12,425					
48	†60,000										
49	†210,000										
50	†490,000										
51	†332,420										
	$1,458,257	$602,514	$1,810,856	$511,720	$2,597,501	$199,408	$2,963,713	$178,277	$2,588,240	$2,347,243	$11,097
	$1,877,025	$1,396,560				$958,795			$886,141		
	*$996,627								*$627,334		
	$4,331,909	$1,999,074	$1,810,856	$511,720	$2,597,501	$1,458,203	$2,963,713	$178,277	$4,101,715	$2,347,243	$11,097

NOTE — * indicates that the plans and estimates have been approved but contracts not awarded.
NOTE — † indicates that the plans and estimates have not yet been submitted to the Canal Board because of a lack of funds for performing the work.
All figures are given to the nearest dollar.

TABLE II.

SUMMARY OF ORIGINAL CONTRACTS AND ESTIMATES.

(For details see Table I.)

LOCATION.	Approved by Canal Board.	Awarded.	Approved but not awarded.	Yet to be approved.	Totals.
Erie Canal, E. D.	$2,454,884	$1,458,257	$996,627	$1,877,025	$4,331,909
Erie Canal, M. D.	2,597,501	2,597,501	....	....	2,597,501
Erie Canal, W. D.	3,215,574	2,588,240	627,334	886,141	4,101,715
Totals	$8,267,959	$6,643,998	$1,623,961	$2,763,166	$11,031,125
Champlain Canal, total	602,514	602,514	....	1,396,560	1,999,074
Oswego Canal, total	499,408	499,408	....	959,795	1,458,203
Grand totals	$9,369,881	$7,745,920	$1,623,961	$5,118,521	$14,488,402
All estimates at contract prices	....	7,121,812	....	....	....
Difference between engineer's estimates and contract prices on all contracts now awarded	....	624,108	....	....	....

TABLE III.

SUMMARY OF EXTENT OF WORK COMPLETED AND TO BE COMPLETED.

ERIE CANAL.	Miles length.	Miles under contract.	Miles completed.	Miles to be awarded.
Eastern Division	106.237	50.170	4.380	51.687
Middle Division	97.023	97.023	Nos. 12, 14, 17	00.000
Western Division	147.773	112.160	No. 4	35.618
Total Erie Canal	351.033	259.353	4.380	87.300
Oswego Canal	38.300	10.290	3.070	24.940
Champlain Canal	65.000	25.620	4.300	35.080
Grand total	454.333	295.263	11.750	147.320

NOTE.—The raising of the four dams on the Oswego Canal will flood the levels above same to the required depth, so that virtually 12 miles more than is shown by the above is under contract in consequence.

Middle Division contracts Nos. 12, 14 and 17 and Western Division contract No. 4, were for structures, the rebuilding of which added practically nothing to the amount of mileage completed.

4

CANAL IMPROVEMENT (RECAPITULATION)

And Estimate of Probable Total Cost.

Total amount of engineer's estimates for all contracts	$14,448,402
Total amount of advertising and inspection paid	147,079
Total amount of engineering expenses paid	512,000
	$15,107,481
Add for work not in original estimates in addition to difference of $624,108 between engineer's estimates and estimates at contract prices	495,019
Add for further expenses of advertising and inspection	125,000
Add for further expenses of engineering	350,000
	$16,077,500
Cr.	
By funds from chapter 320, Laws of 1895 (used for lengthening locks 21 and 22 and improving level between same—Eastern Division Contract No. 11)	77,500
Total estimated cost of canal improvement	$16,000,000

TABLE IV.

Summary of Expenses of Superintendent of Public Works.

For advertising and inspection to October 1, 1897.

Eastern Division.				Middle Division.				Western Division.	
Erie canal.		Champlain canal.		Erie canal.		Oswego canal.		Erie canal.	
Adv.	Insp.	Adv.	Insp.	Adv.	Insp.	Adv.	Insp.	Adv.	Insp.
$24,671	$9,499	$6,966	$5,690	$25,404	$19,919	$19,619	$7,073	$10,127	$10,766

Total advertising	$86,787
Total inspection	52,947
General inspection and disinfectants	7,345
Grand total	$147,079

TABLE V.

SUMMARY OF ENGINEERING EXPENSES PAID.

To October 1, 1897.

Eastern Division.		Middle Division.		Western Division.	Total.
Erie canal.	Champlain.	Erie.	Oswego.	Erie.	All canals.
$117,000	$61,500	$123,500	$33,000	$177,000	$512,000

TABLE VI.

CANAL IMPROVEMENT.

Summary of monthly estimates, showing total amounts earned to October 1, 1897.

CONTRACT NO.	Eastern Division.		Middle Division.		Western Division.
	Erie.	Champlain.	Erie.	Oswego.	Erie.
1	....	....	$151,610	....	$511,360
2	$21,400	....	200,070	....	244,750
3	86,760	....	153,470	....	59,740
4	25,980	....	259,570	....	*11,097
5	80,610	....	128,530	....	78,620
6	46,320	....	....	$10,840	....
7	*141,591	....	....	5,020	....
8	....	*$89,940	....	9,290	....
9	....	*116,634	....	12,730	....
10	....	101,040	....	35,940	....
11	*118,240	....	....	*32,182	....
12	70,940	....	*15,950	....	....
13	*45,315	....	*15,570	....	....
14	....	....	*17,867	....	....
15	....	....	....	20,160	....
16	....	....	....	100,075	....
17	....	....	*9,402	....	....
18	....	....	106,450	....	....
19	....	....	65,630	....	....
20	....	....	3,230	....	....

TABLE VI.—CANAL IMPROVEMENT—(*Concluded*).

CONTRACT NO.	EASTERN DIVISION.		MIDDLE DIVISION.		WESTERN DIVISION.
	Erie.	Champlain.	Erie.	Oswego.	Erie.
23	....	....	$2,340	....	....
24	....	....	1,420	....	....
25	....	....	1,150	....	....
26	....	....	9,700	....	....
27	....	....	9,640	....	....
28	....	....	11,310	....	....
Totals	$637,156	$307,614	$1,162,909	$226,237	$905,567

RECAPITULATION.

Grand total for Erie canal	$2,705,632
Grand total for Champlain canal	307,614
Grand total for Oswego canal	226,237
Grand total	$3,239,483

NOTE.—Amounts shown are to the nearest even dollar.
NOTE.—Asterisks indicate the amounts of final estimates that have been paid.

It does not seem to be necessary at this time to describe in detail the progress of the work on each of the several contracts. Those that have been awarded are well under way, and the date fixed for the completion of all that have been awarded is prior to the opening of navigation next spring. Some of them, however, will require an extension of time, since with this rush of work it is impossible for all of the contractors to procure the materials necessary (principally stone) to complete their work. The work thus far done will compare favorably with any similar work that has ever been done on the canals, and will reduce the cost of maintenance to a minimum for many years to come. It is, of course, unfortunate that it cannot be completed for the sum originally appropriated. However, this Department has never said that the work could be done for that sum, and in my report to the Constitutional Convention under date of August 1, 1894 (see report of proceedings of the Constitutional Convention, vol. 2, document No. 41), I estimated the cost of the work to be as follows:

For 9 feet of water, Erie canal	$5,310,000
For 9 feet of water, Oswego canal	1,208,000
For 7 feet of water, Champlain canal	2,300,000
For lengthening Erie and Oswego locks	2,755,000
Total	$11,573,000

The Superintendent of Public Works, then Mr. Edward Hannan, submitted an estimate to the Constitutional Convention under date of July 25, 1894 (see report of proceedings of the Constitutional Convention, vol. 2, document No. 34), which was as follows, for the same work:

For 9 feet of water, Erie canal....................	$4,601,000
For 9 feet of water, Oswego canal.................	1,004,000
For 7 feet of water, Champlain canal..............	1,366,000
For lengthening Erie and Oswego locks............	2,485,000
Total..................................	$9,456,000

Ex-State Engineer Martin Schenck assisted Mr. Hannan in the preparation of the latter report, in which it was distinctly stated that no data existed either in this or the Superintendent of Public Works offices on which to base a reliable estimate of cost. Twelve days were consumed in making these estimates, not a survey was made, and no one familiar with the facts could reasonably assume that those estimates were anything more than they were stated at the time to be, namely, as close an approximation as it was possible to make from a mere general knowledge of the length of the work, and without knowledge, except of the most general kind, as to the condition of the walls and structures. Nearly three-fourths of the whole cost of the present improvement is involved in these walls and structures, and that cost is for work that cannot be avoided, and is absolutely essential as a part of the deepening. As the work progresses, it is found that enormous quantities of the old slope and vertical walls, which it was thought, even after an examination of the work preparatory to making the plans on which the work was afterwards awarded, could be saved, are found to be in such condition, either from poor original work or from old age and the action of the elements, that they cannot possibly be underpinned and saved, and that they must be rebuilt.

To anyone not especially familiar with all the conditions, it would appear to be a very simple matter to prepare plans for this work. It looks like a simple matter to say that the canal shall be made two feet deeper by lowering the bottom one foot and raising the banks one foot, or wholly by raising or lowering, but it proved to be a matter of no small moment to decide just how to obtain the required additional depth of water on each level, that is, whether wholly by lowering or by raising, or by both, and to what extent.

From Buffalo to Lockport this feature was determined by the lowest level of Lake Erie and the additional area of prism and grade thereof required to feed for 150 miles (to Montezuma) the additional quantity of water required for the deepened canal and the certainty of largely increased filtration which will ensue the disturbance of the old silted canal bottom. This was fixed at 9 feet below the lowest level of Lake Erie.

In other cases the elevation of important structures, as the top of a costly culvert, the bottom of an aqueduct or the floor of a lock, fixed this determination, since in some cases such structures could not be changed except at a great cost, though from every other standpoint it might have been cheaper to get the required depth in some other manner. This also applies especially to most of the feeder levels, though in a few cases these can be raised by also raising the feeder banks.

Through nearly every city along the canals, the raising of the water surface would entail the raising of many bridges and the approaches thereto, which are already too steep, and would doubtless cause many claims for damages from leakage and the flooding of cellars which are otherwise above water surface. The disarrangement of shipping facilities of the numerous establishments

on the canal banks in these cities was also worthy of careful consideration, and because of these features, most of the levels through the cities and larger towns are improved wholly by deepening.

In other cases this decision was based wholly on comparative estimates of cost, or on the practicability of underpinning and saving the old walls, but in each and every case a proper determination as to the most expedient plan to be adopted could only be arrived at by careful and complete surveys and estimates and hence at large expense for engineering.

These surveys are entirely completed and the plans for the several contracts based thereon are also practically completed except for a few structures. This will account for what may appear to be an undue cost of engineering as compared with the amount of construction work done, as shown by the foregoing tables.

The surveys for the entire work were started January 13, 1896, which was within forty-eight hours of the time when we were notified by the Comptroller that the funds for starting the work were available. The entire length of the three canals—454 miles—was soon covered by these surveys. The plans and profiles were then studied with as much care as the limited time available would permit us, and the estimates of cost based thereon were available early in 1896. These were necessarily based largely on the judgment of the various engineers in charge in the several sections, and to their credit, be it said, that the grand total thereof amounted almost exactly to the sum now known to be required.

It was, however, believed that many items had found their way into these estimates that could be omitted, and after revising a few of these, covering some of the most important sections, a few

contracts were awarded. These covered an amount sufficient to use up the funds provided by the Legislature of 1895, and as no more contracts could be awarded till more funds were available, the intervening months were spent in the most rigid scrutiny of every plan and estimate in the effort to bring the total cost within $9,000,000. Every resource for procuring new and cheap materials, for new designs of features where greater economy seemed possible, for eliminating entirely the rebuilding of structures that were already tottering, was tried and exhausted, not without good results, but without accomplishing the object sought.

A glance at the accompanying tables, which show that after revising the estimates for all work, they still show a total (Engineer's estimate) of $14,448,402, will indicate plainly why it is impossible to make $9,000,000 cover the 454 miles of work to be improved. Further argument along that line seems superfluous. Such a radical difference was not to be overcome by any form of economy, even to the extent of slighting a good portion of the work. Notwithstanding the apparent impossibility of reducing the total cost to the sum available, the estimates for each contract were repeatedly revised in this effort to reduce cost, and it now appears that the effort made in that direction has resulted in cutting out a large amount of work which experience shows cannot be avoided, and which is a necessary part of the other work. Many miles of vertical and slope walls that were known to be urgently needed were eliminated altogether, as well as the rebuilding of many miles of old walls and hundreds of structures which, though known to be in a badly dilapidated condition, were believed capable of lasting a few years longer, until other funds could be made available for their reconstruction.

But it is one thing to say that such items could and must be

eliminated and decidedly a different thing to do the balance of the work in such manner as to make this possible. A few instances illustrating this point may not be amiss.

Between Buffalo and Tonawanda it was at first believed that all necessary excavation could be made without building new walls or protecting the old slopes, and the contract (Western Division No. 2) was awarded on that basis. This section of the canal is on the very bank of the Niagara river, and runs wholly through a strata of very treacherous clay, which when wet will slide on a very flat slope.

The excavation in the bottom of the prism was started, and though the old slopes were not touched, they began to slide into the canal, and a serious crack, one and a quarter miles long, developed in the tow path, threatening to effectually close the canals. Under such circumstances and in view of the disastrous effect of a break in the banks anywhere on this section, but one thing could be done, viz.: To stop the excavation until the banks had been protected. This was done and the latter feature will entail a cost not originally contemplated of nearly $150,000, though the plans therefor are the cheapest that could be devised after much consultation and study.

The work through the city of Buffalo also gives many startling instances of the unknown quantities incident to this work. This section of the canal being at the same water surface as Lake Erie must be drained artificially, and as this had not been done in over thirty years, little could be known or ascertained concerning the condition of the old walls, bridge abutments, culverts, unrecorded sewers and other structures, or even of the nature of the materials to be excavated, though the estimates for the latter feature are very close. It must be understood that the depth of excavation on

this section was from 2 to 4 feet on the center, while along the walls this depth was from 5 to 9 feet. The condition of the greater portion of the walls, therefore, could not possibly be ascertained until the canal had been drained and the excavation completed. New canal bottom on this section is barely 9 feet below the low water surface of Lake Erie.

As the latter work progressed it was found that a great part of the vertical walls were not founded on rock, but on a single timber with about one foot of earth intervening between it and rock. It was found almost impossible to underpin and save walls so built, and in many cases where it was attempted the walls afterward fell in. It was then seen that while the faces of the walls seemed to indicate a fair grade of work, they were laid up absolutely without bond, the face stones merely forming a veneer for the loose backing that had apparently been simply dumped into place. The photographs accompanying this report fully illustrate these features and also show the difference between the old and new walls.

The Erie and Genesee street bridges on this contract are also worthy of comment. As the excavation at these points progressed, it was found that the abutments for these heavy bridges were not carried down even to the level of the old canal bottom, but were from 8 to 10 feet above same and, therefore, from 11 to 14 feet above new canal bottom. Both were founded on treacherous clay, and at Genesee street an old forgotten sewer had completely saturated the foundation of the north abutment, in which it ended and by which its outlet was cut off.

The rebuilding of these structures meant a serious outlay and interruption of traffic, but it was soon found to be unavoidable, for, while trying to save them, both failed and fell into the canal.

The removal of the water from this section of the canal necessarily took from its walls a large factor of sustaining pressure, and this fact has materially aided the collapse of many pieces of old wall.

Another section of the work that has been prolific of increased cost over the estimates and of difficulties to be encountered is the "Jordan Level" on the middle division, extending between locks 50 and 51. This section runs almost wholly through a swamp, underlaid with the most treacherous marl and quicksand, the water surface of the canal being above the surface of the swamp in many places. This feature has rendered the draining of the work a very serious matter. The weight of water which accumulates back of the banks during the winter and spring months has in many places formed a sufficient extra load to cause the banks to slide on their unstable foundations, and it has been deemed expedient to insure the integrity of the deepened canal to construct several large permanent ditches to keep the surface water away from the canal banks. This work was not originally contemplated. It was originally believed the new slope walls would be built along this level by founding them on short piles about eight feet long, and much of the work so built is standing in good shape, though for many miles of the distance it was found almost impossible to keep such piling in position long enough to complete the work. Long rows of them driven during a given day would be found the following morning lifted bodily and toppled over in the canal. Other piles of 30 and even 40 feet in length were driven, and these also would lift bodily from six to eight feet in one night, though, strange to say, these when redriven usually remained in place.

On a large part of this level the excavation from canal bottom

has been done several times, since it has been a frequent experience to find that the canal bottom of a completed section had lifted suddenly to a greater height than when the first excavation was started.

Bridge abutments along this section slid into the canal, simply from being relieved of the counter-balancing weight of the superstructure while attempting to raise the latter to the new required height. These have had to be rebuilt at considerable cost.

Every device has been suggested or tried to restrain and control this material and complete the work in a thorough manner, but this certainly cannot be done without largely increased cost, and it is equally certain that these conditions could not well have been foreseen nor avoided if foreseen. In other localities the disturbance of the old, silted canal bottom has developed a large amount of leakage and this becomes a very serious matter where it happens in a village, as at Ilion and Fort Plain, where many cellars were flooded and it was found imperative to build expensive drains to collect and carry off such leakage.

Since the water has been withdrawn from the Champlain canal, a piece of the towpath about 1,000 feet in length on contract No. 10, but near which no work has yet been done, has broken away of its own weight and about half the towing path and the walls along same for the distance stated have slipped into the canal. None of the contractors' operations have been carried on in this vicinity and the present condition of affairs is simply due to old age and forces beyond the control of any one. Of course there is nothing to do but to restore the work that has thus been destroyed and its restoration will add to the cost of contract No. 10 several thousand dollars. Several similar cases have been reported to us in the last few days.

The foregoing instances of how and why the items of increased cost are constantly being encountered will serve to indicate corresponding features on nearly all of the other contracts, though probably the cost of the latter will not be increased at the same ratio as those above mentioned. The experience thus far indicates, however, that the estimated cost will be increased on most of the contracts, though on two of those for which final accounts have been paid, the cost will be seen to be considerably less than the engineer's estimate. On the sections for which contracts have been awarded, the contract prices will be found to equal a total about 8 per cent. less than that of the engineer's estimates, and the difference will go a long way toward paying for items and quantities not originally contemplated. At the same time the reason for using the engineer's estimates instead of the estimates at contract prices as the basis of probable total cost in the accompanying tables will be apparent. It is a physical impossibility to determine definitely before these contracts are awarded the total quantities of the various kinds of work that will be required. This can only be determined as the work progresses and unexpected conditions are uncovered.

It should be understood that the contractors do not agree to complete a given section of the work for a given sum. What they do agree to is to do any required amount of the several kinds of work enumerated in their contract at rates fixed therein. In other words they are paid for what they actually do—no more, no less.

It should also be borne in mind that practically every feature of the three canals in question is over seventy years old and it should therefore be expected that nature's forces during this long time have not helped to keep the various features of these canals in good condition.

The whole work can be likened to the well known unsatisfactory task of remodeling an old house and any one who has ever undertaken that task will appreciate the force of the comparison. Every step in the new work seems to reveal something in the old that was either unforeseen or supposed to be avoidable, and that process goes on to the end.

The unforeseen or supposedly avoidable features in this work will amount to a vast sum of money, but not a penny of this has been or will be paid until the plans covering such work, together with a written explanation of each and every item of cost, have been submitted to the canal board and duly approved.

The features of the work involving additional quantities or extra items prevail to a greater or less degree throughout the length of the work.

In order to give a fair idea of the great cost of the vertical walls it may be stated that 20 miles (one side only) will consume a million dollars. Bear in mind that the whole work involved is 454 miles long.

The old slope walls constitute another of the important features involving additional cost. Comparatively a small amount of the old slope walls was exposed to view when the original surveys and estimates were made. Along most of the work the walls were covered by deep snow and even after this had been removed or melted away, the lower portion of most of the walls were found to be covered to a considerable depth with silt. Thousands of test pits have been dug to ascertain the exact conditions as nearly as possible, still it is found on removing the silt that much of these walls is unfit for further service—in fact, large quantities have slid into the canal as a result of the necessary excavations.

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These walls form the only protection to the banks over the greater portion of the three canals and some protection of this kind is absolutely necessary. The conditions are dealt with as they are encountered, and the fact that the quantities are increased beyond the amounts shown in the contracts does not in any manner indicate that the contractors are being overpaid. It is certainly equitable for the State to pay at a fair rate for all the work it orders done.

Another feature of the work where additional quantities and sometimes a total change of plan are made necessary is in the uncovering of a gravel or other porous bed in the bottom of the canal, so that large leaks develop, frequently with injurious effects to adjoining property. In many of these cases thousands of dollars have been spent in past years in removing a quantity of such porous materials and replacing them with clay puddled into place or with concrete. In many cases this work has been done so many years ago and no record thereof properly filed that the actual conditions have long since been forgotten.

Such conditions are frequent occurences, and while the localities of some of them are well known, there are many other cases that are wholly unexpected. There is only one thing to be done under the circumstances, namely to increase the quantities of excavation, lining, puddling, sheet piling and concrete and make the canal tight or else expend a large amount of money in building drains to take care of the leakage.

Most of the old structures are in a dilapidated condition, but frequently the actual conditions are not ascertained until the excavations have progressed to such an extent as to reveal the foundations. Many of the old structures appear to have been well built above the grade or foundation line, while the work below same is found to be of a very inferior class.

Under the specifications any material that cannot be plowed is classified and paid for as solid rock. There is a considerable amount of this class of work on each of the three divisions that was originally estimated as earth, because to all appearances it was earth and the top portion of same could easily be plowed. After having been uncovered and its true nature ascertained, and after making the most exhaustive attempts to remove same without blasting, and failing to do so, the material must be paid for as rock according to the contract. This will largely increase some of the estimates.

A great many of the old culverts have performed their work satisfactorily and were supposed to be in a fit condition to continue to do so for many years, but after making the necessary excavation the tops of some of these have been found so near to the bed of the canal that it has been thought best to uncover them and ascertain their exact condition. It was then seen that they could not longer be depended upon to hold back the water in the canal after the earth over them had been removed, and it has been necessary in some cases to remove the old covering altogether and substitute better construction, while in other cases an additional course of concrete or a layer of clay puddle has been placed over the tops and found to work satisfactorily. If any considerable leakage should develop at one of these culverts it might easily lead to a break of considerable magnitude, the mending of which would cost many times the amount involved to prevent such a break, beside the further necessity of delaying traffic.

The old aqueducts are in about the same general condition physically as the balance of the structures, and it is not always possible to determine the exact condition of these structures even when the water is out of the canal. Nearly all of them are very

old and there are but very few that are still capable of carrying the old depth of seven feet of water, while it is certain that they will not carry nine nor even eight feet. Some of these structures, which at the time the original estimates were made were supposed to be capable of lasting several years longer, are now found to be utterly unfit for further use. Two cases in point are the Crane Brook aqueduct and the Port Byron aqueduct on the Middle Division.

The strains which these old structures have encountered during the past season of navigation have placed them in a critical condition, and they must be rebuilt before the opening of navigation next spring. The additional cost of making such of these aqueducts as require rebuilding available for nine feet of water instead of eight feet is almost nothing and in nearly every such case they will be arranged for nine feet of water.

If the whole work covered only a few miles it would be comparatively easy to carefully investigate each and every feature connected therewith and determine the probable cost with far greater accuracy than is consistent with reasonable cost of the 454 miles of work embraced in this improvement plan. Moreover, practically all the surveys and investigations concerning the physical conditions of the work must necessarily be made during the winter months, when the ground is frozen or covered with snow, thereby rendering it difficult, if not quite impossible, to determine these features with any considerable degree of accuracy. It might naturally be supposed that this office would have an almost infinite variety and amount of useful data concerning the old work and the plans of the structures, but that is not the case. The available records are decidedly meagre and even some of those available have been found to be abso-

lutely untrustworthy. For instance, there are plans showing improved locks founded on solid rock, when, as a matter of fact we have discovered that they are founded on piling. Numerous instances of this kind have been found.

Ex-State Engineer Schenck in preparing ex-Superintendent Hannan's report to the Constitutional Convention called especial attention to the fact that neither of our Departments had any reliable data to form a basis for the estimates of cost of the work now under way. It has been supposed by many that careful plans and estimates had been prepared for improving the canals under what is known as the "Seymour plan" (substantially the plan now being pursued) and it seems but proper for us to state here that that plan was simply and only a suggestion from ex-State Engineer Seymour as to what should be done to improve the canals, and no plans nor estimates based thereon were ever prepared by him or his successors. A few words concerning the scope of the present work, therefore, seem to be warranted.

The laws governing this work direct a new depth of nine feet of water on the Erie and Oswego canals, except over aqueducts, mitre-sills and other permanent structures, where the depth must be at least eight feet.

It will be apparent at a glance, then, that a depth of one foot below and between these structures would produce practically no results, and it is equally apparent that if nine feet of water could be had over these structures each boat could load to one foot more draft, or an additional paying load of fifty tons, or an increase of twenty per cent. in that paying load. Therefore, by obtaining this depth throughout, instead of only between strucures, a gain for the boatmen equal to that obtained from the entire balance of the work might be accomplished. With this

act in view it was but natural that we should attempt to obtain nine feet throughout. If all the old structures were otherwise fit for the new work, this could only be done at great cost, but as a matter of fact nearly every such structure requires either alteration or rebuilding, and it is found that the additional cost of fixing these structures for nine feet of water, over what is otherwise required is almost insignificant. For instance, if an old timber aqueduct is too far decayed to be able to carry eight feet of water, and must be rebuilt anyhow, the additional cost of rebuilding for nine feet depth is almost nil. The additional cost of lowering a lock floor two feet instead of one foot will not amount to over $500, on the plan that has been used and proven successful at locks 46, 49 and 50. (See illustrations in appendix.)

It would be ridiculously foolish not to take advantage of these opportunities for acquiring nine feet of water, especially on the Erie canal, and consequently that general policy is being pursued.

However, it should not be inferred that all work is being made to conform arbitrarily to this standard. On the contrary, there will be quite a number of places where there will be but eight feet of water after the improvements are completed. These occur at structures where it is not absolutely necessary to do any work to obtain eight feet of water, and they are, therefore, planned to be left in their present shape for a few years more until the necessity for rebuilding them will offer the opportunity of making them conform to the nine feet standard. These constitute the only changes that are being made in the much discussed "Seymour plan" for the improvement of the canals, except for the lengthening of the locks, but no work on the locks differing from the Seymour plan has yet been done, except in the preparation of plans and estimates.

LOCK LENGTHENING.

We have heretofore suggested that great benefits to our canal commerce would follow the lengthening of all locks, not only to double boat length, but to such length as to permit the passage of two boats each 115 feet long, instead of 98 feet, as at present. This would enable each boat to add over 17 per cent. to its paying load without materially increasing its resistance to propulsion. Much study has been given to this feature, but no actual work towards its consummation has been done, principally because all the old locks yet to be lengthened, except at Little Falls, must be treated in a different manner than has yet been tried, because of their peculiar location and surroundings. The Erie locks remaining to be lengthened are as follows:

Two near Albany, sixteen at Cohoes, four at Little Falls, three at Newark, five at Lockport.

Locks 21 and 22 of the Erie canal have been lengthened under the present improvement and were used during the past season. These are located at either end of a sharp curve, and some difficulty has been experienced in turning two boats, west bound, so as to enter lock 22. This condition could be greatly improved by extending the towpath on the south side of the canal from the new change bridge east of lock 21 across the upper Mohawk aqueduct to the present bridge just west of this aqueduct. With the towpath on the outside of the curve, between these locks, the tendency is to pull the boats toward the towpath. In order to enter the lengthened chamber of lock 22, which is on the opposite side from the towpath, they should be pulled away from the new towpath.

As 85 per cent. of the canal traffic passes into the Hudson river

at Troy, the great expense of lengthening locks 1 and 2, near Albany, hardly seems justified. It will be impossible to lengthen lock No. 1 on its present location.

A great deal of study has been devoted to the subject of lengthening the four locks at Little Falls, Nos. 36, 37, 38 and 39, and several different plans and estimates have been prepared to get a clear idea of comparative cost and desirability. These studies seem to indicate that the cheapest, and, doubtless, the most expedient course to pursue is to lengthen all of these locks substantially in accordance with the plan that has heretofore been followed in similar cases.

The three locks at Newark, Nos. 57, 58 and 59, present a peculiar problem. It will be impossible to lengthen all of them in their present location on account of the sharp curves on which they are located and still enable boats to enter and leave them freely, and even though this could be done, it is believed to be cheaper to change the route at this point and combine these three locks, which are of low lift, into two of greater lift. This course would save the time required for passing one lock.

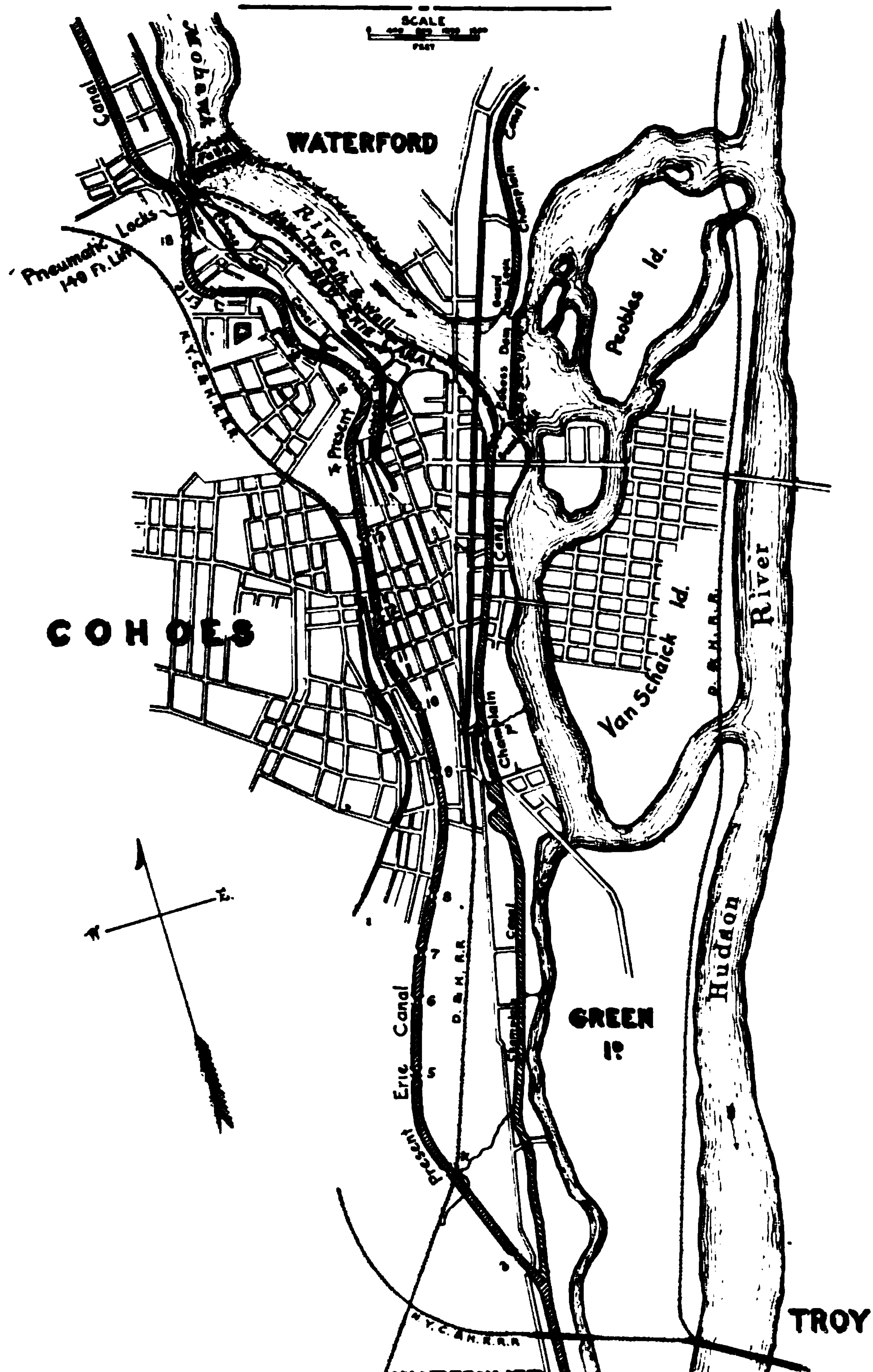
At Lockport another peculiar situation is encountered and it will be found physicially impossible to lengthen the present series of five locks at that point during the five months in which the canals are closed, especially if the locks are to be lengthened in the usual manner. To do this would necessitate the closing of the Erie canal during one season of navigation, or at least a greater part of it, and that is, of course, out of the question. A complete set of plans for a steel lift lock, similar to the one proposed for Cohoes, has been prepared for this point, and they have been approved by the canal board. Considerable of the preparatory work under these plans could be done during the season

MAP

Showing proposed new route of the

ERIE CANAL

from the head of "The Sixteens" (Lock No 18) at Cohoes, to a new junction with the Champlain Canal at the south side of the Cohoes Dam.



of navigation, and the locks could be completed during the closed season, but whether this was done or not, the plan at this point contemplates leaving the old locks intact and placing the proposed structure just south thereof, so as not to interfere with the old locks in any manner. Aside from the question of possibilities of doing any work at this point within a given time, the steel lift lock will be found far cheaper than any other plan. This subject has been canvassed very thoroughly during the past two years, and three complete sets of plans have been prepared, representing as many different methods of accomplishing the desired end. We have selected the one which seems best able to meet all the requirements after much careful consideration.

The plans for this lock, and also that proposed for Cohoes, will be capable of passing two boats coupled together, each 115 feet long. At Lockport, as at Cohoes, a great saving in operating expenses, and the expense to the boatmen for hauling the extra boats of each fleet, as well as a considerable saving of time, could be effected.

PROPOSED CHANGE IN ROUTE AT COHOES.

The series known as "the sixteens" (3 to 18) at Cohoes are scattered along a distance of over three miles, and follow a tortuous, dangerous, side-hill route throughout that distance. To lengthen these locks and improve the levels between them will certainly cost $1,800,000, owing to their peculiar location and surroundings and the dilapidated condition of the present canal.

An exceptionally advantageous alternative route is offered at this point, as shown on the map submitted herewith. Briefly, this plan contemplates the improvement of that portion of the

present Champlain canal between its junction with the Erie canal and the Cohoes dam to the improved Erie canal standard, then at a point just south of the guard lock at the south end of the Cohoes dam a new channel of standard Erie dimensions is designed to be built in the bed of the Mohawk river and along the southerly side thereof. This channel would be protected from the flood waters of the river by a wall and embankment which will form the towpath. This work would be about a mile in length, and will lead up to a point just below the high falls at Cohoes. At this point the plans call for a steel lock, to be operated mechanically, with compressed air as the power. This one lock will overcome the difference in elevation between the river level and the present level of the Erie canal above lock 18, with one vertical life of about 140 feet. From the top of this lock a steel aqueduct about 500 feet in length will lead to and connect with the present channel of the Erie canal at a point just above lock 18.

After making the most liberal allowance, it seems absolutely certain that this change of route will enable us to effect a saving over the cost of improving the Erie canal along its present route of at least $600,000, and a still further saving of at least $40,000 per year in the operating expenses can certainly be effected, while the annual repair item on this section which, because of its old and dangerous condition, is now expensive, can be practically eliminated for many years to come, because we would have a new canal, instead of an old one, to maintain. Moreover, the saving of time for each boat of from four to eight hours, depending upon the briskness of traffic, can be made on each trip. As most of the boats make seven round trips per year, it will be seen that this saving is well worth making.

Under present methods of navigation, most of the boats run in fleets of four, with only one propeller, and since the fleet has to be broken up at these locks, and the levels between them are too short to warrant connecting the fleet again, it becomes necessary for each boat, aside from the propeller, to hire an extra team and helmsman. This extra cost to the boatmen could be saved under the proposed new plan.

If this route be adopted, the present route for a distance of three and one-third miles could be abandoned and sold for a handsome sum, which could be applied on the cost of the new route, thus adding largely to the saving of cost.

As the proposed lift locks would use practically no water, the amount now required to operate "the sixteens" could be utilized for power to the great advantage of the Cohoes mills, as they are now obliged to suspend work for lack of water during several weeks of each year.

The plans for the work to be done, if this route is adopted, are very nearly completed, and the work could be started within two months, if the necessary funds were available.

PHOTOGRAPHS.

In an appendix to this report will be found a large number of photographs, which show the salient features of portions of the canal improvement work, with special reference to the character of the old walls and structures. These do not represent exceptional cases; they are characteristic of most of the work.

STATE LANDS.

Throughout the past year an unusually large amount of correspondence has been received from surveyors, attorneys and other sources in different parts of the State, asking for copies of the

records, field notes, maps, etc., the originals of which are on file in this office. These represent the original surveys of a large portion of the entire State, and particularly of the Adirondack section, where the State has recently acquired title to many thousands of acres. Many of these records are very old; some of them were made during the early part of the last century, and as they form the original description of boundary lines and monuments, they are of great value and importance as recently developed in connection with the newly acquired lands of the State Forest Preserve. The value of many of these documents is constantly increasing with the growing demands for the acquisition of the remaining land necessary for the completion of the Adirondack park. As is usual with such old records their value is seldom appreciated— except by those who have occasion to refer to them—until time and constant handling have seriously impaired their usefulness, and the records in question are no exception to the general rule.

Many of these old documents were poorly executed in the beginning, some were on very poor paper which has grown exceedingly brittle, and in many cases of this kind the paper is rapidly crumbling away. Many of them are done with such poor ink that they are now barely legible, and if they should perchance be destroyed or lost, there is now no way to replace them.

Chapter 790 of the Laws of 1897 appropriated $1,000 for copying and preserving these old records, but, owing to the fact that the office has been almost constantly torn up during the past year in connection with the repairs which have been made to this building, it has not been possible to accomplish as much of this work as was desired. This appropriation will probably not be sufficient to cover the copying of all of these old records, and it

surely will not make any provision for their greater safety; hence, I recommend that a further appropriation of $4,000 be included in this year's supply bill, so that this work can be pushed to completion, and a suitable modern safe provided for their protection.

There have been received and reported on during the past year seventy-nine applications for grants of land under water, of which seventy were for "beneficial enjoyment" and nine for "purposes of commerce," situated in the different counties as follows:

Jefferson, 3; Kings, 40; New York, 2; Niagara, 2; Queens, 9; Richmond, 11; Rockland, 2; Westchester, 5; and Albany, Chautauqua, Cayuga, Columbia and Greene, 1 each; from which it will be seen that there were 60 applications from the counties of Kings, Queens and Richmond, which was due to the efforts of riparian owners to obtain grants before January 1, 1898, when the charter of the city of Greater New York became operative.

The statutes direct that the State Engineer and Surveyor shall sell at public auction all of those unappropriated lands of the State which may be ordered sold by the commissioners of the land office, as well as all lands acquired by the State through tax sales, foreclosures of United States mortgages, escheats, etc. During the past fiscal year there were sold 194 parcels, located in 12 counties as follows:

Chautauqua, 2; Kings, 18; Niagara, 7; Onondaga, 4; Rockland, 4; Richmond, 74; and Albany, Allegany, Herkimer and Oswego, 1 each.

The Constitution of the State provides that the State Engineer and Surveyor shall be one of the commissioners of the land office, and as such, all applications to that body for grants of land under navigable water are referred to this department for examination and report, as are also a large number of miscellaneous matters

relating to State lands. These maps and papers require careful inspection, and consume and receive a great deal of time.

The maps and papers are examined to determine their correctness and proper form, both from an engineering standpoint and to insure their conformity to the rules and regulations of the commissioners of the land office, and to determine whether or not the making of the grant would interfere with navigation, and that the lines conform to the pier and bulkhead lines where they are established and are equitable, and do not conflict with the rights of the adjoining riparian owners. During the past year a number of these applications for water grants have been contested, or had remonstrances filed against them, and hearings have been necessary to determine the rights of the several interested parties, and the adjudication of the contested matter, and reporting the outcome to the commissioners of the land office.

SURVEYS FOR THE COURT OF CLAIMS.

These surveys, made under the direction of this department, furnish the attorney-general with maps and data on which, in most cases, he bases his defense of the suits against the State for damages arising from overflow and accidents usually connected with the canals.

The engineer in charge of this work gives expert testimony, covering a wide range, mostly in the line of hydraulics, and furnishes estimates of damage done and cost of restoring the property to its original condition. The greatest degree of accuracy is necessary in reestablishing the "Blue Line," i. e., the boundary of the lands owned by the State of New York, which becomes necessary in a majority of cases, and involves the claimants' rights to bring action against the State. In many cases it takes days

of careful field work to identify these old lines which were originally established in the year 1834. Many cases involve larger surveys covering miles in their extent. This is true on the Middle and Western Divisions where the discharge of the waste weirs of the canals enters creeks that are very winding in their course with little fall toward the outlet. Running through flat lands or old lake bottoms, the waters easily leave the banks and flood immense territories. As these waste weirs are only used during heavy rains, the waters so discharged are generally considered to be responsible for all damage done and it becomes the duty of the engineer, to gather information to disprove, if possible, this assumption. A survey is made and a topographical map prepared which shows the area flooded, the lands of each claimant and lands that escaped flooding by reason of their higher elevations. A careful search for statistics as to rainfall, etc., is made and photographs taken, proving, by showing damage in adjacent districts, that heavy rains and not the waters of the canal were responsible for the damage.

During the past year one corps of engineers was stationed at Fayetteville making an extensive survey of lands alleged to have been damaged by reason of discharge of canal waters into Lime Stone creek at Manlius Centre and extending nearly to Oneida lake, covering over 20 square miles. This same party also made surveys of many pieces of property lying along the Champlain canal where damages were alleged. Another party was in camp near Stillwater in the Adirondacks, running the flow line of the Mary L. Fisher property which was flooded by raising the Beaver river dam at this point. This survey involved the establishing of a six foot flow line around the above mentioned property and bounding the same by a transit line which is the boundary of the

lands taken by the State for reservoir purposes. This line, following its various courses, is nearly 42 miles long, and required a large amount of work.

The Legislature appropriated $7,000 for work of this character by chapter 790 of the Laws of 1897, but this has not proved sufficient and some surveys have had to be postponed on account of the lack of money. An appropriation of at least $15,000 should be made in the ensuing year, as many claims for damages will arise incident to the improvement now going on, on the different canals, and some very heavy storms which occurred during the last year foreshadow the filing of a vast number of claims on the Middle and Western Divisions.

During the year testimony was given involving as many as 120 cases, notably those located on Wood creek in Oneida county, and test cases in those located on Tonawanda creek. Many cases were dismissed on the maps, photographs and testimony furnished by this department and damages so materially cut down that the appropriation for that purpose pays for itself many times over.

For a number of years this work has been under the efficient supervision of First Assistant Engineer, T. C. Leutze.

ORDINARY AND EXTRAORDINARY REPAIRS.

The present condition of those parts of the canals on which no work has yet been done under the canal improvement work, is the best evidence that could be produced that the usual fund for the ordinary repairs and maintenance of the canals is not sufficient to do the work that is now required to put them in proper condition. While the sums annually appropriated seem, at first glance, to be large, it will also be seen, when considering the great length of

work to be covered, that it will accomplish comparatively little, especially in view of the fact that a great majority of the walls and structures are over 70 years old, and, therefore, require in many cases not only repairs, but total reconstruction. To proceed in the usual way and prepare a special law for each piece of work, would mean an endless amount of labor and expense for the Legislature and the departments interested, and there seems to be no good reason why the precedent that has been established by the passage of blanket repair laws similar to chapters 947 of the Laws of 1896 and 566 of the Laws of 1897 should not be followed this year. The former law appropriated $125,000 for each of the three divisions, and the latter $360,000 for the entire system, and provided that these funds should be used subject to the approval of the canal board wherever the State Engineer and Superintendent of Public Works might agree it was for the best interests of the State. This makes it possible for those charged with the repair and maintenance of the canals to do an enormous amount of work that is absolutely necessary, and that could not be accomplished if the funds therefor were dependent on special laws. I earnestly recommend that a similar law be enacted for the work of the coming season, and suggest that the amount should be larger, rather than smaller, than that heretofore named.

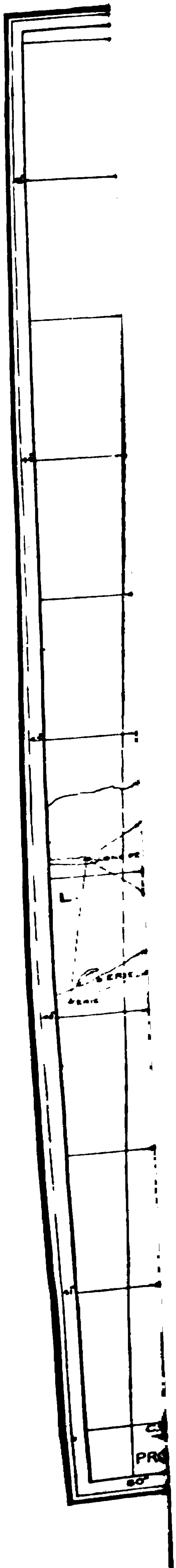
STATE BOUNDARY LINES.

The law directs that this department shall see to it that the various monuments which mark the location of the boundary lines of the State be frequently inspected, and that monuments that may have been destroyed from any cause be replaced, to the end that the location of these lines where they have been fixed shall not be lost.

A great deal of work of this character has been done in recent years, and we are now making an effort to prepare a proper record of these boundary lines, showing by maps the location of the various monuments, and the topography of the country in the vicinity of these lines, and also preparing sketches or photographs of each monument, so that they can be easily found when wanted. Until recently all the record that we had of these lines was scattered through an enormous number of documents on file here, so that it seemed almost impossible to get at the information when it was needed. The new records will simplify this matter, as it is proposed to compile all the data relating to the boundaries of each of the adjoining States in a volume which shall be complete in itself. This record will be of inestimable value. The record of the New York and Connecticut line was competed last year. The New Jersey boundary is nearly completed, and surveys have been made during the past season, to determine and fix the Massachusetts boundary. In each case this work is done under the joint supervision of the properly constituted bureau of the several States, to the end that the lines and points agreed upon shall be fixed beyond dispute.

CO-OPERATIVE TOPOGRAPHIC SURVEY.

Chapter 391 of the general laws of 1897 authorized the State Engineer and Surveyor to continue to co-operate with the director of the United States Geological Survey in making a topographic survey and map of the State of New York, and appropriated for this work the sum of $15,000. In addition, there remained available an unexpended balance of $612.49 of the appropriation of $10,000 made by chapter 320 of the general laws of 1896 for surveys in the Upper Hudson valley, and this sum I allotted to



the continuation of co-operative topographic surveys in that region, to be met by a like appropriation by the director of the United States Geological Survey. Moreover, there remained of the appropriation of $10,000 made in chapter 480 of the general laws of 1896, an unexpended balance of $2,181.37, which was available for field work in the season of 1897, making a total sum of $17,793.86 of State funds available for these topographic surveys.

In accordance with the provisions of the law of 1897 above quoted, an agreement was signed by the Hon. Chas. D. Walcott, Director of the United States Geological Survey and myself, which is similar in all essential details to agreements made in former years between this office and the United States Geological Survey. As a result of such agreement, the Federal survey allotted to this work the sum of $15,612.49, so that there was available for topographic surveys within the State of New York during the season of 1897 a total sum of $33,406.35, the Federal bureau having expended in the previous season more than their share of the co-operative money for the field work of 1896, from which there remained a balance of the State money amounting to $2,187.37.

I append hereto the report of the Director of the United States Geological Survey, which summarizes the results of the field season's operations under the above acts. I also append descriptions and positions of primary triangulation stations located in the course of the prosecution of this work and lists of permanent bench-marks established by spirit leveling. In this connection I also call to your attention the accompanying outline maps which show the progress of triangulation and topographic surveys to date within the limits of the State. This report and the accompanying diagrams and lists of positions and elevations I commend

to your careful attention and examination and feel sure that you will not fail to appreciate as I do the satisfactory and economic progress which has been made toward the completion of a creditable topographic map of this great State.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C., *January* 3, 1898.

Hon. C. W. ADAMS, *State Engineer and Surveyor, Albany, N. Y.:*

Sir.— I have the honor to make herewith a preliminary statement of the work done under the agreement signed May 20, 1897, by you on behalf of the State of New York, and by me on behalf of the United States Geological Survey.

By the terms of that agreement, $15,000 was allotted by you for expenditure in making the co-operative topographic surveys therein arranged for. In addition, in August, 1897, you made a still further allotment to this work, for expenditure on the head-waters of the Hudson river, of $612.49, making a total new appropriation by you for co-operative topographic work during the season of 1897 of $15,612.49. This bureau has, under the terms of the agreement, allotted a like amount to this work. Since there remained at the beginning of the field season an unexpended balance of the State appropriation of 1896, amounting to $2,181.37, there was accordingly available for field work in 1897 a total sum of $33,406.35.

The result of this co-operation has been the making of an accurate topographic survey on the scale of 1:62,500, or approximately one mile to the inch, and with a contour interval of 20 feet, of 2,258 square miles within the area of the State of New York, of which 425 square miles consist of a revision of the Staten Island,

Harlem and Brooklyn sheets in order to bring the representation of the culture up to date. Moreover, an accurate system of primary triangulation was expanded in portions of Cattaraugus county and in portions of Hamilton, Herkimer, Lewis and Oneida counties, for the adjustment and control of topographic work of 1897, in such amount as to control three additional atlas sheets for future work, while accurate spirit levels were run with such frequency as to permit of the placing of one permanent benchmark in every six miles square of the area surveyed.

The total cost for field work of triangulation was $2,755 for an area of 1,370 square miles controlled, or at the rate of $2 per square mile. The total cost for field work of topography was $19,662, or at the rate of $8.70 per square mile mapped. The total cost, including estimated expenses of completing the map work in office during the coming winter, is $25,520, or at the rate of $11.29 per square mile.

Immediately upon the signing of the agreement under which this work was prosecuted, Mr. W. J. Peters proceeded to the neighborhood of Olean and Salamanca, where he extended triangulation for the control of the Salamanca quadrangle; thence he went to Hamilton and Herkimer counties, where he completed triangulation for the control of the Old Forge and Remsen quadrangles, mapped during the current season, and for future control of Canada lake, Wilmurt and Piseco lake quadrangles, discontinuing field work in the State for the season early in September. In May Mr. Jennings commenced field work on the Brockport, Hamlin and Salamanca quadrangles, later on completing the survey of Old Forge quadrangle. Mr. Clark completed the surveys on Brockport and Salamanca quadrangles, later surveying Oyster Bay and Hempstead quadrangles. Mr. Sutton undertook the re-

vision of the Harlem, Brooklyn and Staten Island quadrangles, and during midsummer aided in the completion of the Old Forge quadrangle. Messrs. Thom and Wheat aided during the season in the revision of the Harlem, Brooklyn and Staten Island quadrangles. Mr. Lovell completed the survey of the Indian Lake quadrangle and aided in the completion of the survey of Remsen quadrangle. Mr. Bassett surveyed Tully quadrangle and aided later in the completion of the survey of Salamanca and Remsen quadrangles. Mr. Walker completed the survey of Cazenovia quadrangle and aided in the survey of Remsen quadrangle. Field work for all these parties was concluded in November and early in December, and office work on the final draughting has already been commenced.

At the close of the field season there remained $6,043 unexpended balance of New York money, and $3,768 unexpended on account of allotment by this survey. Estimating for the salaries and other expenses connected with the office work of map making, there will probably remain an unexpended balance of $3,950 of the sum appropriated by both organizations which will be available for field work exclusive of permanent salaries. This sum I estimate as sufficient to meet the field expenses of surveying from two to four atlas sheets, according to the country. With your approval I would, therefore, suggest that it be devoted in the early spring to the survey of some cheaply mapped region of mild climate as the Baldwinsville, Oswego, Cortland, Berne or Schoharie quadrangles. I would scarcely advise the survey of Wilmurt or other Adirondack areas until later in the season. On this matter I should be glad to have you advise me.

Very respectfully,

CHAS. D. WALCOTT,

Director.

PLANS.

Immediately upon the signing of the co-operative agreement, and after consultation with Mr. H. M. Wilson, geographer of the United States Geological Survey, in charge of topograhpic surveys on the Atlantic slope, it was decided that the season of 1897 should be devoted to the survey of such areas as would throw the most light on the problems of additional water supply for the State canals, while one or two other areas were mapped in order that a few well-distributed localities without the watershed of the State canals might receive some benefit from this great work. Accordingly, it was decided to map in the latter category the Salamanca quadrangle, lying wholly within Cattaraugus county, and of great geologic and economic interest in connection with the development of the oil supplies of the southwestern portion of the State, and it was decided to expend a small sum in revising that portion of the previously mapped quadrangles which include Greater New York, in order that when that city came into being there might already exist an accurate topographic map of its territory on which all temporary features, as roads, houses, railroads, etc., should be represented to date. In this connection it was deemed desirable to extend the surveys on Long Island to the eastward of Brooklyn, so as to complete the mapping of Oyster Bay and Hempstead quadrangles, as these furnish data for the study of important problems connected with the water supply of the city of Brooklyn.

Contiguous to the State canals, it was planned to map the unsurveyed portions of the western divisions of the Erie canal included within the area of the Brockport and Hamlin quadrangles; also to map the southern feeders of the middle division near the

Rome summit, included within the areas of the Tully and Onondaga quadrangles; also to extend the mapping of the Upper Hudson valley, so as to complete the survey of the Indian lake quadrangle, and make a beginning in the survey of the watershed of West Canada and Black rivers by mapping the Remsen and Old Forge quadrangles and, if possible, the Wilmurt quadrangle. In order that this mapping might go forward, it was necessary to extend primary triangulation over portions of the regions above outlined.

It is a fact worthy of note that the United States Geological Survey has in the past season, as during previous seasons, succeeded in completing all the work planned and within the limit of the sums appropriated as necessary for such work. All of the above outlined work has been completed during the past field season with the exception of the survey of the Wilmurt quadrangle, and there remains a sufficient unexpended balance to more than permit of the completion of this survey, prior to the end of the government fiscal year in June next.

TRIANGULATION.

Early in May Mr. W. J. Peters, topographer of the United States Geological Survey, assisted by Mr. G. P. Phillip, was assigned the duty of extending primary triangulation in Cattaraugus county from the line "Learn-Clarksville," established by this survey in the preceding year, to the westward, so as to furnish control for the topographic survey of the Salamanca quadrangle. This work was completed within a couple of weeks, resulting in the determination of the positions of two additional stations, namely, "Flat Iron," in southern Olean township, and "Townsend," near the corner of Salamanca, Great Valley, Carrolton and Red House town.

Upon the completion of this work, Messrs. Peters and Philip proceeded to Herkimer and Hamilton counties, where they extended a chain of triangulation from the line "Snowy Mountain-Mt. Hamilton," established by this survey during the preceding season, in a southwesterly direction, to connect with the Coast Survey line "Penn-Schuyler." This work resulted in the determination of the geodetic positions of ten new stations, and furnished control for the topographic mapping of the Remsen, Wilmurt, Piseco Lake, Old Forge and Canada Lakes quadrangles. As but two of these were mapped during the last year, there still remains trigonometric control for three additional sheets within this portion of the Adirondack region. The triangulation of this area was greatly hampered during June and July by the unusually heavy and persistent rainfall, and the work was accordingly somewhat more expensive than would otherwise have been the case. It was, however, satisfactorily completed during the first week in September, and Messrs. Peters and Philip then discontinued field work for the season.

The result of primary triangulation conducted by this survey during the past season was perhaps more important than that of any previous year. For a total expenditure of $2,641.89 there were controlled by triangulation 1,300 square miles, or an average cost of $2.03 per square mile controlled. More important, however, is the fact that a belt of precise triangulation has now been extended entirely across the most rugged and inaccessible portions of the Adirondacks from the neighborhood of Lake Champlain and on Lake George, in a westerly and southerly direction over Mt. Marcy, Schroon lake, Blue Mountain lake, Lake Pleasant and Fulton chain of lakes to the level country about Utica and Rome.

In the prosecution of the above trigonometric work, an average of five direct and five reverse readings was made of each angle with a large 8 inch Fauth theodolite reading with micrometer microscopes, to two seconds of arc, and this work was done with such care that the average closure error of the triangles was less than three seconds. Elsewhere are published the results of the computation of the geodetic positions of the points located. Each of the stations occupied by the triangulation party during the past season is permanently marked, upon the ground by means of a copper bolt four inches in length, firmly embedded in solid rock, and on the surface of the copper bolt is stamped (Fig. 1, c.) the letters " U. S. G. S., N. Y. and the serial number of the station.

It is worthy of note that to date there have been located by this survey and its predecessor, the State or Gardner survey, 480 positions, and that these, with the positions already located by the United States coast and geodetic survey and the United States lake survey, cover, with sufficient detail to furnish control for topographic mapping, a total area of 28,000 square miles of the State, or 61 per cent. of the area of the State.

MERIDIAN MARKS.

In accordance with the regulations of the United States geological survey, within all the areas covered by primary triangulation there is established at each county seat a meridian or azimuth line, which is marked by two stone posts set firmly in the ground and capped with bronze tablets bearing suitable inscriptions in (Fig. 2). This meridian line being a true north and south line will be of great value to county and local surveyors in adjusting their compasses and determining the declination

thereof. Moreover, at the time of establishing these meridian lines the declination of the compass needle is measured and from it the declination at that point may be derived at any period of time.

TOPOGRAPHY.

In accordance with the plan approved by me at the opening of the field season, topographic parties were placed in the field about the middle of May. These parties did not work continuously in the same areas, but were shifted about during the season as the exigencies of the work required so that at times several men worked upon portions of the same quadrangles.

Mr. J. H. Jennings executed the planetable triangulation and supervised the spirit leveling for the Brockport and Hamlin quadrangles, and then performed the same work on the Salamanca quadrangle, and finally, after planetabling the Old Forge quadrangle, he sketched the topography of its northern half. Mr. E. B. Clark followed Mr. Jennings, sketching the topography of the Brockport and Hamlin quadrangles. Later he took charge of and completed all of the surveying connected with the mapping of Oyster bay and Hempstead quadrangles. Mr. Walker mapped the Cazenovia quadrangle, and then executed planetable triangulation for the Remsen quadrangle. Mr. Bassett mapped the Tully quadrangle and then, following Mr. Jennings, sketched the topography on the Salamanca quadrangle, and later following Mr. Walker, sketched the topography of the northern half of the Remsen quadrangle. Mr. Lovell completed the mapping of Indian lake quadrangle, and following Mr. Walker mapped the southern half of the Remsen quadrangle. Mr. Sutton had general supervision of the resurvey of Harlem, Brooklyn and Staten Island quadrangles, in which work he was assisted at various

times by Messrs. Wheat, Thom and Cummin. During the months of August and September Mr. Sutton temporarily left this work to aid Mr. Jennings on the Old Forge quadrangle, the south-eastern half of which he surveyed. The net result of the field work of these various parties is summed up in the following table.

County.	Atlas Sheets.	Area, Sq. miles.	Remarks.
Hamilton	Indian Lake	155	Sheet completed.
Hamilton, Herkimer	Old Forge	216	" "
Herkimer, Oneida	Remsen	217	" "
Monroe, Genesee	Brockport	218	" "
Monroe	Hamlin	87	" "
Cattaraugus	Salamanca	222	" "
Cortland, Onondaga, Madison	Cazenovia	219	" "
Cortland, Onondaga	Tully	219	" "
Queens	Hempstead	145	" "
Queens	Oyster Bay	135	" "
New York, Westchester	Harlem	183	Revision completed.
Kings, Queens	Brooklyn	164	" "
Kings, Richmond, New York	Staten Island	78	" "
		2,258	

The parties working in the Adirondacks were engaged in mapping some of the most rugged portions of that region where travel was exclusively by canoe or on foot over trails or through brush, swamps and woods. Moreover, the work was much hampered during July and August by excessive rains, and as a consequence the cost of this work was higher than elsewhere and higher than usual. A portion of the Old Forge sheet had been previously mapped carefully by the Adirondack League club, the work having been executed by a topographer of the United States Geological survey who was given leave of absence for this purpose. Its quality was therefore well known and otherwise believed to be sufficiently good to permit of its incorporation in the work of the cooperative survey. Arrangements were therefore concluded

by which this map which covered an area of about 90 square miles, was purchased from the club for five hundred dollars ($500), a figure considerably below that for which it could have been resurveyed by the cooperative survey. Of this map, 56 square miles fell within the area of the Old Forge quadrangle, the remainder being on the McKeever, Wilmurt and Canada lake quadrangles, which have as yet not been mapped by the cooperative survey.

The following table gives a summary of the instrumental control, the rate of mapping and the cost per square mile, both for field work alone and for field work and office mapping. The extreme differences observable in this table in the rates of area mapped per day, amounts of control per square inch of map and cost per mile, are due as much to the differences in the topography of the various areas surveyed as to the differences in the speed and abilities of the topographers themselves.

COUNTIES.	Quadrangle.	Topographers.	Number of days work.	Area Mapped, Square Miles. Total.	Area Mapped, Square Miles. Per day.	Triangulation Locations. Total number.	Triangulation Locations. Per square inch.	Spirit Leveling. Benchmarks, total number.	Spirit Leveling. Miles, total number.	Spirit Leveling. Elevations. Total number.	Spirit Leveling. Elevations. Per sq. inch.	Traverse. Miles, total number.	Traverse. Per sq. inch.	Cost Per Square Mile. Field work only.	Cost Per Square Mile. Total, including office work.
Herkimer Hamilton	Old Forge	Jennings Sutton	98	159	1.6	190	1.2	10	60	355	2.2	595	3.7	$20 95	$25 00
Hamilton	Indian Lake	Lovell	50	155	3.1	560	3.6	8	65	590	3.8	260	1.7	15 20	18 60
Monroe Genesee	Brockport Hamlin	Jennings Clark	40	305	7.6	145	0.5	9	60	100	0.3	630	2.0	3 40	4 35
Cattaraugus	Salamanca	Jennings Bassett	68	222	3.2	395	1.8	6	75	230	1.0	335	1.5	7 95	10 00
Westchester, Queens, New York, Kings	Harlem Brooklyn Staten Island	Sutton Thom Wheat	166	425	2.5	....	......	Revision.	...	......	....	......	....	5 72	7 05
Queens Westchester	Hempstead Oyster Bay	Clark	63	280	4.4	98	0.4	15	85	250	1.0	940	3.3	7 72	9 20
Madison Cortland Onondaga	Cazenovia	Walker	63	219	3.5	315	1.4	10	72	385	1.8	620	2.8	6 70	7 05
Cortland Onondaga	Tully	Bassett	55	219	4.0	590	2.7	11	80	330	1.5	645	2.9	7 30	9 15
Oneida Herkimer	Remsen	Walker Lovell Bassett	73	217	3.0	240	1.1	8	40	260	1.2	615	2.8	9 30	11 00
			676	2,200	3.2	2,533	1.1	77	537	2,495	1.1	4,640	2.1	$8 43	$10 05

SPIRIT LEVELING.

Two leveling parties were actively engaged in running primary spirit levels throughout the entire season for the determination of elevations upon which to base the contouring and also in accordance with the regulations of the United States Geological Survey, to establish one permanent bench mark in every six miles square of the area mapped.

These levels are executed with greater care than is usually taken in the running of spirit levels. The limit of error set is approximately such that any determination shall not be in error more than ½ foot in a distance of 100 linear miles, and this limit is determined by so arranging the lines of levels that they shall check back upon each other or upon their initial points in order that their error of closure may be ascertained. In other words the lines are run in circuits over the areas mapped, and as each quadrangle comprises an area approximately 13 by 17 miles, at least six permanent bench marks must be established at widely separated points on this area. In addition to the permanent bench marks numerous temporary bench marks are left, such as nails in roots of trees, chiseled marks on stones, etc.

The elevations so determined are based on mean sea level as brought by the precise levels of the United States Coast and Geodetic Survey from tidewater at Sandy Hook to Albany and thence by the precise levels of the United States Engineer Corps along the route of the State canals to Lake Ontario. To these precise levels are tied all of the spirit levels of the co-operative survey and it thus becomes possible to stamp upon the permanent bench marks their elevations to the nearest foot above mean sea level. The permanent bench marks are of three kinds; copper tablets 4 inches in length and 1 inch in diameter sunk their

full length in holes drilled in solid rock and marked as shown in Fig. 1, d. with the elevation to the nearest foot; iron posts, capped by bronze tablets, as shown in Fig. 3, 4 feet in length and planted for more than three-fourths of their length in the ground where solid rocks cannot be found; and finally, bronze or aluminum tablets, marked as shown in Fig. 4 and set into masonry structures. On these is stamped in addition to the elevation above mean tide, an initial letter which corresponds to the particular datum point upon which the levels in that locality are based, groups of levels not being as yet adjusted for the entire State as it has not been all leveled, but being adjusted in series dependent upon some centrally located and well known city in which the initial bench-mark is placed. Hereafter such benchmarks will not only bear the legend "U. S. Geological Survey," but also the name "New York," in order to fully show the co-operation between the two organizations, as is done with the meridian marks already described. During the past field season there were run in all 537 linear miles of such levels, in the course of which there were established 77 permanent bench-marks.

WOODLAND MAPS.

In addition to the topographic map on which are shown the relief of the country by contour lines, the hydrography or drainage, and culture or the works of man, there is also indicated the outlines of all wooded areas. These are tinted in green upon manuscript copies kept in the office of the United States Geological Survey and duplicates of these are furnished this office when called for. These woodland maps have been of great assistance to the State Forest Commission and to the Forest Preserve Board and to others who are engaged in a study of the forest resources of the State of New York.

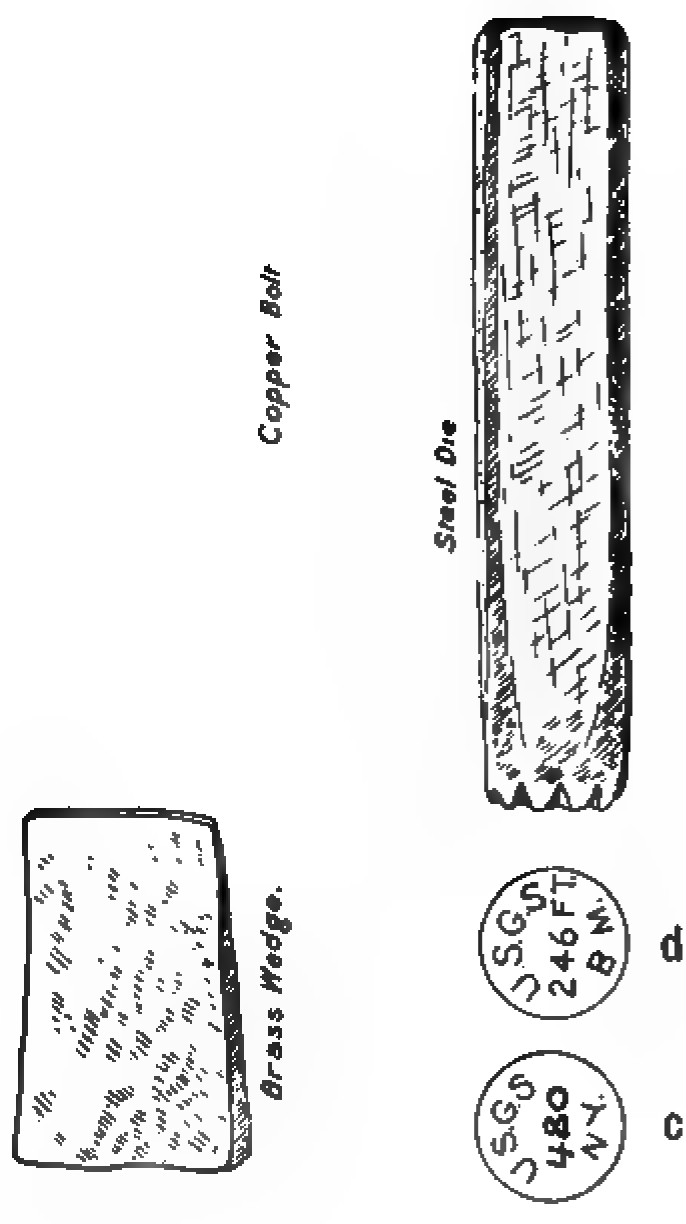
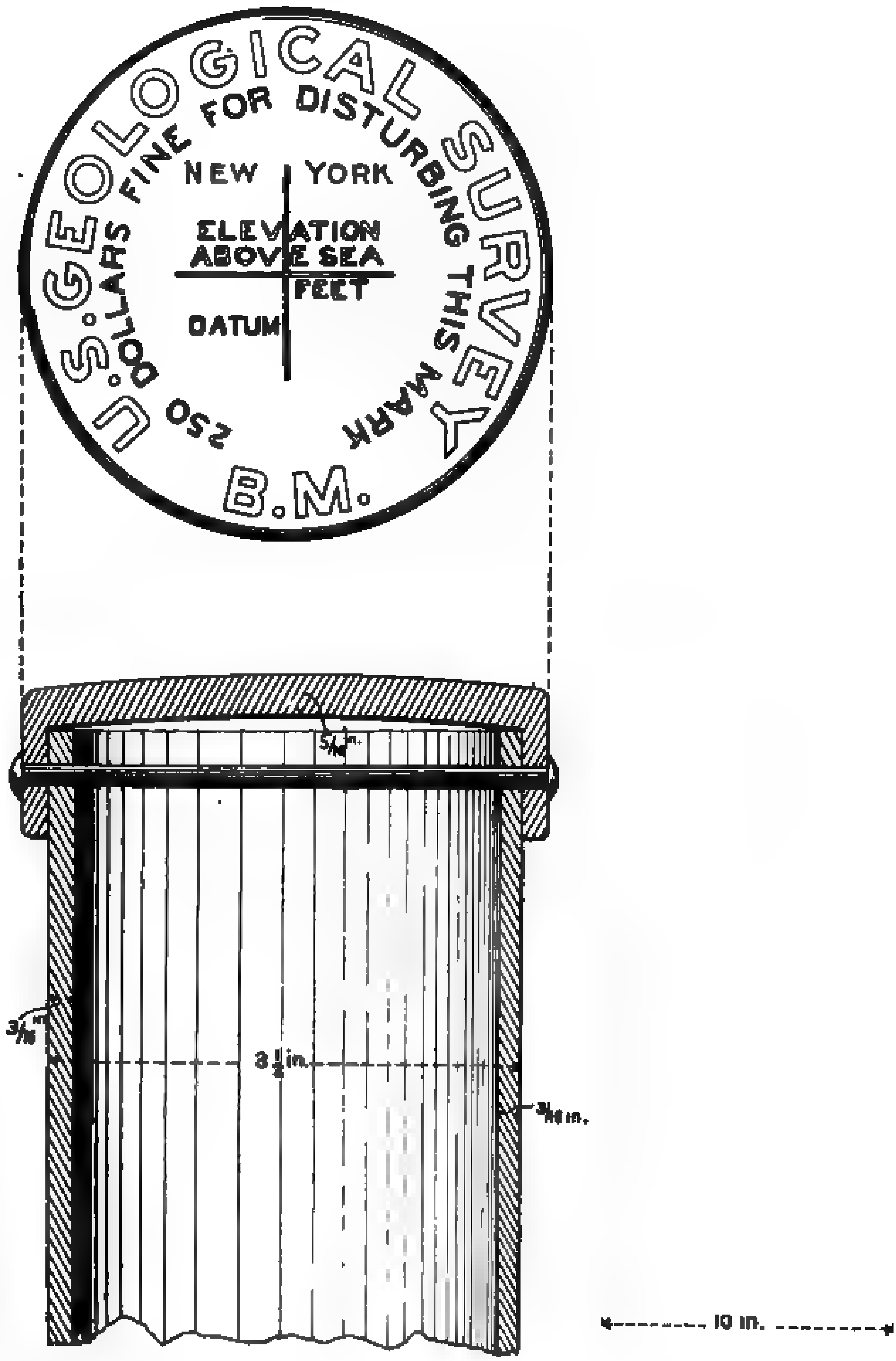

Copper Bolt
Steel Die
Brass Wedge.
U.S.G.S.
246 FT.
B.M.
d
U.S.G.S.
480
N.Y.
c

Fig. 1.


SURVEY
FOR DISTURBING THIS MARK
MERIDIAN MARK
NEW YORK
ELEVATION
FEET
DATUM
250 DOLLARS FINE

Fig. 2.



U.S. GEOLOGICAL SURVEY
250 DOLLARS FINE FOR DISTURBING THIS MARK
NEW YORK
ELEVATION ABOVE SEA
FEET
DATUM
B.M.
5/16 in.
3/16 in.
3 1/2 in.
3/16 in.
10 in.

Fig. 3.


U.S. GEOLOGICAL SURVEY
250 DOLLARS FINE FOR DISTURBING THIS MARK
NEW YORK
ELEVATION
ABOVE SEA
417 FEET
DATUM UTICA
B.M.

Fig. 4

PUBLISHED ATLAS SHEETS.

In the following table are given the names areas and location by counties, of all the atlas sheets so far published as a result of this co-operative topographic survey; also, in another column a list of atlas sheets published during the last year. This latter gives an index to the rapidity with which such atlas sheets are being issued. It will be noted that to date there have been published in all 72 separate atlas sheets covering a total of 11,755 square miles, or nearly 25 per cent. of the total area of the State.

SHEET NAME.	County.	Area published in 1897.	Area published in previous years.
Albany	Rensselaer, Albany	....	220.2
Albion	Genesee, Orleans	218.2	....
Amsterdam	Schenectady, Saratoga, Fulton, Montgomery	....	219.0
Ausable	Clinton, Essex	....	213.0
Berlin	Rensselaer	....	165.0
Bolton	Washington, Warren	216.4	....
Brooklyn	Kings, Queens	....	163.8
Buffalo	Erie	....	188.8
Cambridge	Washington	....	218.2
Cape Vincent	Jefferson	....	63.0
Carmel	Putnam, Westchester	....	192.4
Castleton	Washington	.7	....
Catskill	Greene, Ulster, Columbia, Dutchess	....	221.6
Chittenango	Oneida, Oswego, Madison, Onondaga	....	218.2
Clove	Dutchess, Putnam	....	201.0
Cohoes	Rensselaer, Washington, Schenectady, Montgomery	....	219.0
Cornwall	Dutchess	....	18.5
Coxsackie	Albany, Columbia, Greene, Rensselaer	....	220.4
Durham	Albany, Schoharie, Greene	....	220.4
Elizabethtown	Essex	....	215.0
Elmira	Chemung, Steuben	....	219.8
Fonda	Fulton, Montgomery, Schenectady and Schoharie	....	219.0
Fort Ann	Washington	....	217.3
Glens Falls	Washington, Warren, Saratoga	217.3	....
Greenwood Lake	Orange	....	38.1
Harlem	New York, Kings, Queens, Westchester	....	183.0
Hoosick	Washington, Rensselaer	219.0	....
Ithaca	Tompkins, Tioga, Chemung, Schuyler	....	220.8
Kaaterskill	Greene, Ulster	....	220.6
Lake Placid	Clinton, Essex, Franklin	....	213.0
Lockport	Niagara	218.2	....
Medina	Orleans, Genesee, Niagara	218.2	....
Mooers	Clinton	....	218.0
Mount Marcy	Essex	....	215.0
Niagara Falls	Niagara, Erie	....	72.0
North Creek	Warren	216.4	....
Norwalk	Westchester	....	.8
Oak Orchard	Orleans	106.0	....
Olcott	Niagara	100	....
Oneida	Madison, Oneida	....	218.2
Ontario Beach	Monroe	....	25.0
Oriskany	Oneida	....	218.2
Paradox Lake	Essex, Warren	215.5	....
Patterson	New York	....	.4
Pawlet	Washington	....	.2
Pittsfield	Columbia, Rensselaer	....	83.3
Plattsburgh	Clinton, Essex	....	110.0
Poughkeepsie	Dutchess, Ulster, Orange	....	220.8
Port Henry	Essex	....	124.2
Pulaski	Oswego, Jefferson	....	178.0
Ramapo	Rockland, Orange	....	146.5
Rhinebeck	Dutchess, Ulster	....	222.5
Ridgeway	Orleans, Niagara	110.0	....
Rochester	Monroe	....	218.6
Rouse's Point	Clinton	....	132.0

SHEET NAME.	County.	Area published in 1897.	Area published in previous years.
Sackett's Harbor..	Jefferson	....	180.0
Schenectady	Schenectady, Albany and Saratoga.....	....	219.0
Schroon Lake	Essex, Warren	215.5	....
Sheffield	Columbia, Dutchess	....	14.4
Stamford	Westchester............................	....	67.1
Staten Island.....	Richmond, Kings, New York...........	....	77.6
Stony Island......	Jefferson	....	29.0
Syracuse	Oswego, Onondaga	....	218.2
Tarrytown........	Westchester, Rockland	....	217.0
Ticonderoga	Essex, Warren, Washington............	....	108.0
Tonawanda.......	Niagara	....	218.6
Troy	Rensselaer, Albany....................	....	220.2
Watertown	Jefferson, Lewis.......................	....	215.5
West Point	Dutchess, Orange, Rockland, Putnam, Westchester	....	221.6
Whitehall	Washington, Warren	....	151.0
Willsboro.........	Essex	....	160.0
Wilson	Niagara.................................	....	50.8
Totals	....	2271.4	9483.8

In addition to the above list, which includes all published atlas sheets, there yet remain in the hands of the engravers the following, covering 1529.6 square miles, which will shortly be published:

Sheet name.	County.	Area sq. miles.
Auburn	Cayuga, Seneca	219.0
Moravia	Cayuga, Cortland, Tompkins	219.9
Newcomb	Essex, Warren	215.5
Olean	Cattaraugus	221 6
Skaneateles	Cayuga, Cortland, Onondaga	219.0
Thirteenth Lake	Warren, Hamilton, Essex	216.4
Utica	Oneida, Herkimer	218.2
Total		1529.6

Finally, there are the sheets listed in the beginning of this report as having been surveyed during the field season of 1897, so that to date there have been mapped 89 separate sheets, having a total area of 15,118 square miles, or 32 per cent. of the area of the State.

The engraving, printing and issuance of these maps is done at the expense of and by the geological survey. The agreement made between this State and the Federal Bureau stipulates that the State shall have the privilege of making transfers from the copper plates and of publishing the maps themselves if they so desire, but it is evident that it is to the interest of the State not to take advantage of this opportunity since the general government now sells these atlas sheets for the trifling sum of five cents each, or in large quantities at the rate of $2 per hundred. It is not believed that the State could publish and sell these maps at a like low figure, and as they can be obtained in any quantities by the public by merely writing to the Director of the United States Geological Survey and enclosing the purchase-price, there seems

no reason why the State should undertake such publication. It is believed that whereas now engineers and others having uses for such maps are well acquainted with and are constantly obtaining them, they will soon come more generally into the hands of the public when the latter learns how easily they may be procured, and stationers and others who deal in maps are already taking advantage of the opportunity afforded them to obtain their local maps in large quantities and then retailing them at remunerative prices.

It seems unnecessary to recite here the many advantages which accrue to the State by continuing this co-operative survey. No question can be raised of its speed, economy and efficiency. Invariably the surveys have been made within the time and at the cost originally estimated. The work has progressed as surely and rapidly as the amounts of appropriations have permitted. To date there have been expended in all by both the State and the Federal Bureau, $167,000 on this survey, which expenditure has resulted in the survey of 89 separate atlas sheets, covering 15,118 square miles, at an average cost, including 425 miles of revision, of $11.06 per square mile. As has been already stated in previous reports of my predecessors and myself, these maps are engraved on copper and printed from transfers from lithographic stones in three colors. The work is beautifully executed and the three colors are so arranged as to make the map most legible, brown being employed for contour lines, or lines which show the relief or slope of the country; blue for drainage, as lakes, rivers, ponds and oceans; and black for the works of man, as roads, houses, county and town lines and names. Each atlas sheet covers an area of 15 minutes of latitude and longitude, being approximately 13 miles east and west and 17 miles north and south, the area varying

from 212 to 225 square miles, according to the latitude. The scale is one mile to the inch and the vertical interval between contours 20 feet, so that all essential topographic features can be represented upon them.

These maps are of inestimable use to the State government in the study of water supply problems for the State canals, in the investigation of the forestry boards, in planning improvements in connection with the good roads movement, and in investigating disputes relative to town and county boundaries. They are of equal service to city and private engineers in planning supplies for city water works, sewage projects, and in the investigation of real estate and land claims and improvements, in planning railways, electric lines, highways and other engineering works. The average cost of making these surveys is about $10 per square mile, of which the State pays one-half. With this expenditure of $5 per square mile the outlay of the State ends, but that of the Federal Bureau has but commenced. In addition to the field work required for making the topographic manuscript map, the latter then proceeds to engrave and print it at an average cost of one to three dollars per square mile, borne wholly by the Federal government, though the benefits accrue to the State. Moreover, with the completed topographic map as a base, the Federal Bureau proceeds to make a study of the economic geology and of the water resources of the State through its divisions of hydrography and geology, and the results of these investigations made at considerable expense, also accrue to the State without further expenditure by it.

There yet remain 32,540 square miles of the area of the State to be mapped, and I renew my earnest request that you continue this co-operation on such liberal lines as will permit of the completion

of this work within a reasonable length of time. An appropriation of $25,000 to $30,000 per annum, continued for the next six years would witness the completion of this work. I, therefore, hope that you will provide an appropriation of such amount as an item of the supply bill for 1898.

PRIMARY TRIANGULATION.

The work of primary triangulation within the State of New York was conducted in the past season in accordance with fixed rules established for the general triangulation work of the United States Geological Survey. A maximum permissible error of triangle closures and the character of signals and kind of station marks was fixed, and these and other details which have heretofore been left somewhat to the judgment of each individual observer have been so systematized that now no work of this kind within the State is classed as primary which is not executed with a first-class micrometer instrument, reading by two microscopes to at least two seconds of arc.

The following instructions are those governing this work and are published here for the information of those who may be interested in the details of such operations:

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY.

INSTRUCTIONS FOR FIELD WORK OF PRIMARY TRIANGULATION.

1. Signals should be of sawed lumber whenever it can be obtained, and great care must be taken to secure perfect centering of instrument and target over station mark.

2. All stations should be selected with a view to their adaptability to topographic expansion, and when the exact location of a station is decided upon one of the standard iron posts, copper plugs, or bronze tablets must be set as a permanent mark. In light soil a bottle or similar object must be left as a sub-surface mark. These marks should be at exact center of station, and in addition there should be left one or more reference marks. At base-line stations there should be left at least two reference marks.

3. Whenever practicable, set the theodolite over center of station while reading angles, to obviate reduction to center.

4. The theodolite when in use must be sheltered from the sun and wind. When setting the theodolite tripod, leave the head bolt thumb-screws loose until the legs are firmly placed.

5. Never, under any circumstances, attempt to place the circle so that when pointing at any particular station the micrometers will be set to even degrees.

6. Use book No. 9-912 for all field records, and do not crowd notes. Have notes plainly written with No. 4 pencil or with ink, and never erase, but draw a single line through erroneous records.

7. On page immediately preceding record of angles, write a minute and complete description of the station occupied, giving nearest trails or roads, camping places, station marks, etc., as well as ownership of land when possible. Write this description before leaving the station. In addition plat a rough diagram of pointings, showing also plan of eccentric location of instrument, if there be such.

8. Before observations are commenced at a station, test all adjustments of theodolite, and correct such as are found in error, paying special attention to micrometers to avoid the errors of run.

9. For micrometer theodolites, angles must be measured either

by the method of circle readings (directions) or by single angles, and in either case each set of angles must be kept on a single page of note-book. If the method of directions be adopted, each complete set must consist of pointing with telescope direct, and reverse pointing with telescope inverted, always closing horizon. See U. S. G. S. Monograph XXII for additional details in use of micrometer theodolites.

10. No angle should be considered finally determined that has not been measured on at least four different parts of the circle.

11. The error of closure of any triangle in primary schemes should not exceed 5″.

12. Opposite each angle recorded give any necessary information in regard to visibility of signals or atmospheric conditions.

13. Do not trust to memory for notes. Make all notes as complete as though it were expected another person would compute them.

14. Magnetic declination must be determined at each azimuth station and at each county seat.

15. Observations for azimuth on Polaris before and after elongation must be made on two nights from at least one station in each square degree, to consist of not less than 6 angles between mark and star with telescope direct and reversed. See Monograph above referred to for form of record. Great care must be taken in adjusting and leveling the horizontal axis of theodolite. Watch error must be determined by telegraphic comparison of time or by astronomic observations.

16. Two marks of dressed stone or masonry, about 500 feet apart on a true north-and-south line, must be established at each county seat, the center of each to be the cross mark on one of the standard bronze tablets.

17. Angles at each station must be reduced to center of permanent mark in order to test triangle closures. Arbitrary adjustments and preliminary computations should be made in the field. All computations except distances and co-ordinates must be in book No. 9-889.

18. Keep a careful plot of the work on a scale of 10 miles to an inch, and each month send a copy with monthly report, indicating angles measured by the usual signs.

19. On fly-leaf of each note-book write an index of contents of book, and state make and number of theodolite used.

20. The observer should always endeavor to locate prominent points that may be of use to the topographer, or that may be used for future stations.

21. Especial attention must be paid to the location of county courthouses, section and county corners, and State-line marks.

22. Useful locations can often be made by the "three-point method," the theodolite being set up for the purpose while going to or from stations.

23. Keep in view the fact that station names are to be published, and select such as have local significance.

CHAS. D. WALCOTT,

Director.

February 15, 1897.

GEODETIC POSITIONS.

The final last square adjustments of the triangulation executed in 1896 having been completed, the geodetic co-ordinates are here published, as are those of such of the triangulation of 1897, as has been finally adjusted.

Primary triangulation for the Adirondack region for the season of 1896 was based on the geodetic co-ordinates of the stations

Hamilton-Prospect, as given by the United States Coast and Geodetic Survey. That for southwestern New York is based on the geodetic positions of Harrison, Orange, and Swale, as given by the New York State Survey (Gardiner). A least-square figure adjustment has been made of the work in the former region, and an arbitary adjustment of the triangulation in the latter region, which consisted of a belt of single triangles. The field observations of 1896 were made by Mr. W. J. Peters, assisted by Gaston P. Philip. Average closure error of triangles is 4″.7.

HAMILTON, IN HAMILTON COUNTY.

United States Coast and Geodetic Survey triangulation station on highest point of Mount Hamilton, 3 miles southeast of Lake Pleasant, Hamilton county. Cleared of timber.

Station mark: Copper bolt set in solid rock, marked "U. S. G. S. 465 N. Y."

[Latitude, 43° 24′ 41.82″. Longitude, 74° 22′ 00.14″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Prospect	268	28	38.73	88	53	20.26	4 6858085
Gore	221	33	38.32	41	46	44.82	4.5860772
Crane	245	28	19.04	65	44	59.34	4.5547813
Big Range	206	09	35.82	26	14	31.60	4.3397301
Snowy	177	03	15.52	357	02	24.76	4.5065186

PROSPECT IN WARREN COUNTY.

A triangulation station of the United States Coast and Geodetic Survey on the summit of Prospect Mountain, in Warrensburg Township, Warren county, about 5 miles by road southwest of Caldwell. The summit is covered with a second growth of timber about 20 feet high.

Station mark: A dressed granite stone 6 by 6 by 30 inches.

Reference mark: Four dressed stones, 10 feet distance in direction of cardinal points.

[Latitude, 43° 25′ 17.94″. Longitude, 73° 46′ 04.56″]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Hamilton	88	53	20.26	268	28	38.73	4.6858085
Gore	140	40	21.78	320	28	43.29	4.5543688

GORE, IN WARREN COUNTY.

A flat-topped mountain, about 2½ miles southwest of North creek, in the northwest corner of Warren county. The station is on a bare rock near south end of summit. The summit has been cleared at one time, but there is now a second growth.

Station mark: A copper bolt set in solid rock, marked "U. S. G. S. 468 N. Y."

[Latitude, 43° 40′ 15.01″. Longitude, 74° 02′ 58.48″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Snowy	96	56	33.20	276	42	33.72	4.4380049
Crane	333	23	14.45	153	26	49.68	4.1942257
Big Range	60	09	30.24	240	01	18.95	4.2651735
Blue	128	27	41.19	308	13	04.92	4.5577342

CRANE, IN WARREN COUNTY.

A rocky, bare summit in Warren county, about 3 miles northwest of Thurman post-office.

Station mark: Copper bolt set in solid rock, marked "U. S. G. S. 464 N. Y."

[Latitude, 43° 32′ 41.82″. Longitude, 73° 57′ 46.36″.]

To station —	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Hamilton	65	44	59.34	245	28	19.04	4.5547813
Big Range	101	54	15.19	281	42	29.42	4.3706811
Prospect	310	54	38.04	131	02	40.98	4.3199370
Snowy	116	52	24.04	296	44	50.26	4.5836926

BIG RANGE, IN HAMILTON COUNTY.

The most northern peak of three timbered points known as Big Range, in Hamilton county, between the East branch of Sacandaga river and Jessups river.

Station mark: Copper bolt set in solid rock, marked "U. S. G. S. 466 N. Y."

[Latitude, 43° 35′ 17.48″. Longitude, 74° 14′ 50.45″.]

To station —	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Crane	281	42	29.42	101	54	15.19	4.3706811
Gore	240	01	18.95	60	09	30.24	4.2651735
Snowy	137	50	44.87	317	44	57.45	4.2251617

SNOWY, IN HAMILTON COUNTY.

A bare rock-capped mountain in Hamilton county, about 8 miles southwest of Indian Lake post-office.

Station mark: A copper bolt set in solid rock, marked "U. S. G. S. 469 N. Y."

[Latitude, 43° 42′ 00.60.″ Longitude, 74° 23′ 18.81″.]

To station —	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Gore	276	42	33.72	96	56	33.20	4.4380049
Big Range	317	44	57.45	137	50	44.87	4.2251617
Blue	176	34	39.02	356	34	03.53	4.2828778
Vander Whacker	226	39	21.67	46	51	26.23	4.5068594

BLUE, IN HAMILTON COUNTY.

A rock-capped summit in Hamilton county, about 3 miles from "Blue Mountain" village. The summit has been cleared.

Station mark: A copper bolt set in solid rock, marked "U. S. G. S. 470 N. Y."

[Latitude, 43° 58′ 20.98″. Longitude, 74° 24′ 05.10″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Snowy	356	34	03.53	176	34	39.02	4.2828778
Gore	308	13	04.92	128	27	41.19	4.5577342
Vander Whacker	263	14	00.45	83	26	41.71	4.3923451

VANDER WHACKER, IN ESSEX COUNTY.

A rock-capped summit in the southwestern part of Essex county, between North or Hudson river, Boreas river, and the stage road from Aiden Lair to Newcomb. The summit has been cleared.

Station mark: A copper bolt set in solid rock, marked "U. S. G. S. 471 N. Y."

[Latitude, 43° 53′ 58.73″. Longitude, 74° 05′ 46.97″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Blue	83	26	41.71	263	14	00.45	4.3923451
Snowy	46	51	26.23	226	39	21.67	4.5068594
Gore	351	30	01.50	171	31	58.13	4.4073506

SWALE, IN STEUBEN COUNTY.

In lot No. 429, Steuben county, on property of Mr. Burlingame, about 4 miles east of West Cameron, on bare hill.

Station mark: Granite post, marked "429 N. Y. S. S."

[Latitude. 42° 12′ 16.23″. Longitude, 77° 29′ 28.02″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Harrison	28	11	28.77	208	03	10.47	4.5597210
Call	93	17	16.4	273	10	27.2	4.1459946

CALL, IN STEUBEN COUNTY.

Eastern end of long summit known as Call Hill or East Call Hill, in Hartsville Township, Steuben county, about 100 yards south of road from Alfred Center to Bennett creek post-office, and about 3 miles distant from the latter.

Station mark: An iron post with brass cap marked "U. S. Geological Survey B. M. U. S. G. S. 473 N. Y."

[Latitude, 42° 12′ 41.86″. Longitude, 77° 39′ 37.16″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Swale	273	10	27.2	93	17	16.4	4.1459946
Alma	58	25	50.1	238	11	39.8	4.5341817
Ward	101	20	46.0	281	12	21.9	4.2440196
Round Top	56	49	31.0	236	42	19.0	4.2470200

ALMA, IN ALLEGANY COUNTY.

In lot 127, Alma Township, Allegany county, about 1¼ miles east of Pikeville post-office, on property of Mr. Hall, of Wellsville. Cleared toward east; heavily timbered toward west.

Station mark: Iron post with brass cap marked "U. S. Geological Survey B. M. U. S. G. S. 475 N. Y."

[Latitude, 42° 02′ 59.33″. Longitude, 78° 00′ 44.68″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	Meters.
Ward	208	59	28.9	29	05	16.1	4.3887799
Belfast	148	24	04.9	328	17	14.0	4.4278990
Clarksville	110	50	59.8	290	43	32.8	4.2148842
Round Top	239	53	56.0	60	00	54.0	4.2191200

WARD, IN ALLEGANY COUNTY.

On divide between headwaters of Vandermark and Phillips creeks, about 1½ miles southeast of Phillips creek post-office, in lot 29, Ward Township, Allegany county, on property occupied by Mr. A. W. Lamphear.

Station mark: Iron post with brass cap marked "U. S. Geological Survey B. M. U. S. G. S. 472 N Y."

[Latitude, 42° 14′ 32.95″. Longitude, 77° 52′ 07.21″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Alma	29 05 16.1	208 59 28.9	4.3887799
Call	281 12 21.9	101 20 46.0	4.2440196
Belfast	93 11 53.2	272 59 13.0	4.4139140
Round Top	349 26 39.0	169 27 50.0	4.1249400

BELFAST, IN ALLEGANY COUNTY.

In lot 10, Belfast Township, Allegany county, about 8 feet north of road from Black creek to Transit bridge, about 2 miles east of Black creek post-office, and about 4 miles northwest of Friendship.

Station mark: A copper bolt set in granite post 4 feet long by 6 inches square, marked "U. S. G. S. 477 N. Y."

[Latitude, 42° 15′ 18.30″. Longitude, 78° 10′ 56.94″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Alma	328 17 14.0	148 24 04.9	4.4278990
Ward	272 59 13.6	93 11 53.2	4.4139140
Clarksville	4 14 26.8	184 13 50.0	4.2311053
Learn	84 30 35.9	264 20 32.9	4.3151033

CLARKSVILLE, IN ALLEGANY COUNTY.

A partially cleared hill about 3 miles southeast of Clarksville, 3 miles northwest of Bolivar, and 3 miles west of Richburg, in lot 2, Clarksville Township, Allegany county.

Station mark: A copper bolt set in granite post 4 feet long by 6 inches square, marked "U. S. G. S. 476 N. Y."

[Latitude, 42° 06′ 08.00″. Longitude, 78° 11′ 51.74″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Alma	290 43 32.8	110 50 59.8	4.2148842
Belfast	184 13 50.0	4 14 26.8	4.2311053
Learn	127 50 30.6	307 41 05.3	4.3882626

LEARN, IN CATTARAUGUS COUNTY.

In township of Ischua, Cattaraugus county, on property of Mr. Learn, 3 miles west of Bennett creek post-office.

Station mark: A copper bolt set in granite post 4 feet long, marked "U. S. G. S. 478 N. Y."

[Latitude, 42° 14′ 13.27″. Longitude, 78° 25′ 53.79″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Clarksville	307 41 05.3	127 50 30.6	4.3882626
Belfast	264 20 32.9	84 30 35.9	4.3151033

ROUND TOP, IN ALLEGANY COUNTY (not occupied).

Secondary point. In lot 28, Andover Township, Allegany county, on property of Mr. Sullivan, 3 miles southwest of Andover. A cleared point.

Station mark: Iron post with brass cap marked "U. S. Geological Survey B. M. U. S. G. S. 474 N. Y.

[Latitude, 42° 07′ 28 .11″. Longitude, 77° 50′ 20. 78″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Harrison	333 05 15.0	153 10 49.0	4.41344
Call	236 42 19.0	56 49 31.0	4.24702
Alma	60 00 54.0	239 53 56.0	4.21917
Ward	169 27 50.0	349 26 39.0	4.12494

The primary triangulation for the field season of 1897 in Cattaraugus county was based on the line "Learn—Clarksville," established by the triangulation of the preceding year, both of these points having to be reoccupied in order to permit of extension to the westward. The triangulation for the Adirondack region for the season of 1897 was based on the line "Snowy—Hamilton," established by the primary triangulation of last year, but was extended through to the coast survey lines "Bartow—Schuyler" and "Schuyler—Penn," near Rome and Utica, thus furnishing a check upon the quality of that work. A least square adjustment has been made of the work in Cattaraugus county, a preliminary or tentative adjustment of the triangulation only being made in the Adirondack region because any adjustment made there would be disturbed within the next year or two upon the further extension of that triangulation. Moreover, all the angles essential to the completion of that scheme have not been observed, some stations requiring reoccupation and only enough having been done to permit of the immediate utilization of the work in the prosecution of topograghic mapping.

LEARN, IN CATTARAUGUS COUNTY.

Same point occupied as in 1896.

[Latitude, 42° 14′ 18.822″. Longitude, 78° 25′ 58.769″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Belfast	264 20 40.1	4.3150995	20659
Clarksville	307 41 13.2	4.3882610	24449
Flatiron	2 37 16.9	4.3683237	23352
Townsend	61 05 16.4	4.4047580	25396

CLARKSVILLE, IN ALLEGANY COUNTY.

Same point as occupied in 1896. A scaffold rebuilt 40 feet high to see "Learn."

[Latitude, 42° 06′ 08.027″. Longitude, 78° 11′ 51.740″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Belfast	184 13 56.6	4.2311051	17026
Alma	290 43 38.8	4.2148899	16402
Learn	127 50 38.5	4.3882610	24449
Flatiron	67 50 19.9	4.3437861	22069

FLATIRON, IN CATTARAUGUS COUNTY.

Locally known as Flatiron Rock. This station is in Olean township, Cattaraugus county, and is 3 miles south of Olean, on the northeast end of a high ridge forming the divide between Napp creek and Allegany river.

Permanent mark: Copper bolt in solid rock, marked "U. S. G. S. N. Y. 479."

Signal: Heliotrope.

[Latitude, 42° 01′ 37.256″. Longitude, 78° 26′ 40.193″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Clarksville	247 40 24.7	4 3734861	22069
Learn	182 36 45 9	4.3683237	23352
Townsend	117 33 42.7	4.3779127	23873

TOWNSEND, IN CATTARAUGUS COUNTY.

Locally known as Townsend's Hill. The station is in Salamanca township, Cattaraugus county, New York, about 3 miles southeast of Salamanca. There is a private road from the village of Salamanca to the station.

Permanent mark: Iron benchmark post, marked "U. S. Geological Survey, B. M., 480."

Signal: Heliotrope and scaffold.

The instrument has to be elevated 15 feet to see Flatiron.

[Latitude, 42° 07′ 34.253″. Longitude, 78° 42′ 01.628″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Learn	240 54 26.5	4.4047580	25396
Flatiron	297 23 25.2	4.3779127	23873

SNOWY, IN HAMILTON COUNTY.

Description published last year.

[Latitude, 43° 42′ 00.59″. Longitude, 74° 23′ 13.81″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
West Canada	54 26 45	4.52631	33598
Little Moose	77 20 02	4.18149	15188

HAMILTON, IN HAMILTON COUNTY.

Occupied in 1896. U. S. C. and G. S. final position.

[Latitude, 43° 24′ 41.82″. Longitude, 74° 33′ 00.14″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
West Canada	113 22 27	4.49941	31580
Little Moose	150 10 46	4.52004	33116
West creek	64 37 58	4.46489	29167
Fish	131 28 45	4.00362	10084

LITTLE MOOSE, IN HAMILTON COUNTY.

Little Moose, also known as Kismeth, is a cleared mountain summit near the headwaters of West Canada, Cedar, and south branch of Moose rivers, in township 4, Hamilton county, N. Y.

Permanent mark: A copper bolt marked "U. S. G. S. N. Y. 484."

Signal: Four-leg pyramid.

[Latitude, 43° 40′ 13.16″. Longitude, 74° 34′ 15.17.″]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Hamilton	330 02 15.89	4.5200577	33117.5
West Canada	37 33 09.62	4.3112380	20475.7
Bald	105 34 37	4.45662	28617
Woodhull	80 42 07	4.50470	31967
Black	124 42 04	4.27082	18656
Snowy	257 12 28.12	4.1815127	15188.4
Cloud Cap	302 06 54.	3.92652	84430

WEST CANADA, IN HAMILTON COUNTY.

A timbered top about 3,000 feet altitude, 4 miles due east of Forest Lodge on the Adirondack League Club Preserve, in township 7, Hamilton county.

Permanent mark: A copper bolt in solid rock, marked "U. S. G. S. N. Y. 483," over which is built a small mound of stone. Two reference arrows cut in rock outcroppings.

Instrument raised 30 feet.

Signal: A spruce tree trimmed to within 10 feet of top.

[Latitude, 43° 31′ 25.80″. Longitude, 74° 43′ 30.97″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Hamilton	293 07 42.14	4.4994236	31580.8
Snowy	234 12 50.62	4.5263101	33597.7
Little Moose	217 26 46.42	4.3112381	20475.7
Bald	147 39 06	4.45144	28276
Pen	69 52 15	4.66431	46165
Schuyler	38 25 27	4.70919	51191
Myers	80 33 08	4.48810	30768

PEN, IN ONEIDA COUNTY.

U. S. S. S. & G. S. point. A bare hill about 2 miles west of Steuben station, in Steuben township.

Permanent mark: A granite post marked $\overset{U}{\underset{S}{O \times S}}$, with four granite witness posts.

Signal: A four-leg scaffold of sawn lumber.

[Latitude, 43° 22′ 46.56″. Longitude, 75° 15′ 36.36″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
West Creek	280 50 11	4.67194	46983
Schuyler	334 10 22	4.42849	26822
West Canada	249 30 11	4.66431	46165
Ft. Noble	264 17 01	4.55002	35483
Myers	229 47 58	4.22836	16918

BARTO, IN HERKIMER COUNTY.

N. Y. S. S. point. A high, bare hill in Fairfield township, about 1½ miles east of village of Fairfield.

Permanent mark: A stone post marked "N. Y. S. S. 28."

Signal: A four-leg pyramid of wood.

[Latitude, 43° 07′ 50.07″. Longitude, 74° 53′ 24.88″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Cold Brook	145 25 54	4.23313	17105

SCHUYLER, IN HERKIMER COUNTY.

A N. Y. S. S. point in lot 16, Schuyler township, about 6 miles from Poland, on the Poland-Utica old stage road.

Permanent mark: Granite post marked "N. Y. S. S. 203."

Signal: Four-leg pyramid of wood.

[Latitude, 43° 09′ 43.95″. Longitude, 75° 06′ 59.13″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Cold Brook	219 22 05	4.13584	13672
Myers	182 07 13	4.54513	35086
West Creek	246 08 31	4.57643	37708
Pen	154 16 17	4.42849	26822
West Canada	218 09 22	4.70919	51191
Ft. Noble	220 34 40	4.56094	36387

CLOUD CAP.

In Hamilton county. (Not occupied.)

[Latitude, 43° 37′ 46.60″. Longitude, 74° 28′ 56.25″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Little Moose	122 10 32	3.92651	8443.2
West Canada	59 10 15	4.35938	22875.9
Hamilton	238 51 42	4.41430	25960.0
Snowy	224 21 04	4.04014	10968.3

DUG.

In Essex county. (Not occupied.)

[Latitude, 43° 34′ 58.49″. Longitude, 74° 20′ 45.68″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Hamilton	365 02 28	4.28114	1910.5
Big Range	265 45 16	3.90243	7988.0

PEAKED MOUNTAIN.

In Warren county. (Not occupied.)

[Latitude, 43° 43′ 43.52″. Longitude, 74° 08′ 57.03″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Snowy	80 40 41	4.28874	19442
Gore	308 40 19	4.01245	10291

McGINN.

In Hamilton county. (Not occupied.)

[Latitude, 43° 46′ 34.44″. Longitude, 74° 13′ 25.36″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
Blue	126 54 23	4.25129	17836
Snowy	57 19 13	4.19392	15629

SIGNAL N.

In Warren county. (Not occupied.)

[Latitude, 43° 49′ 02.10″. Longitude, 74° 14′ 28.41″.]

To station—	Azimuth.	Log. distance.	Meters.
	° ′ ″		
McGinn	343 03 48	3.67795	4655
Snowy	42 08 54	4.24383	17532

INDIAN LAKE CHURCH SPIRE.

In Hamilton county. (Not occupied.)

[Latitude, 43° 46′ 49.66″. Longitude, 74° 15′ 57.33″.]

To station—	Azimuth.	Log distance.	Meters.
	° ′ ″		
Gore	304 52 34	4.32757	21260
Vanderwhacker	226 05 51	4.27635	18895

GOODNOE.

In Essex county. (Not occupied.)

[Latitude, 43° 57′ 36.40″. Longitude, 74° 12′ 37.27″.]

To station—	Azimuth.	Log distance.	Meters.
	° ′ ″		
McGinn	30 04 30	4.31090	20460
Vanderwhacker	306 51 39	4.05863	11445

KEMPSHALL.

In Hamilton county. (Not occupied.)

[Latitude, 44° 01′ 28.53″. Longitude, 74° 19′ 48.91″.]

To station—	Azimuth.	Log distance.	Meters.
	° ′ ″		
Blue	16 42 09	4.25137	17839
Vanderwhacker	306 42 32	4.36993	23439

PRECISE LEVELS.

The following factors are those employed by the co-operative topographic survey in correcting the elevations of the bench-

marks of the State canals as published in reports of the State Engineer and Surveyor, and the bench-marks of the line of levels run by the United States Engineer Corps from Albany to Oswego, as published in professional papers No. 24, Corps of United States Engineers.

The elevations published by the corps of engineers are based on the old Gristmill bench-mark established by the United States Coast and Geodetic Survey at Greenbush, opposite Albany, the height of which was determined by precise levels run from Sandy Hook in 1877 as being 14.73 feet above mean sea level. The elevations published by the State Engineer of the various bench-marks on the line of the canals are based on mean low water at Albany. A connection has been made between State canal bench-marks and United States engineer corps bench-marks at lock No. 1, and the difference between the two is +1.18 feet. In other words, this amount, added to the State canal elevations reduces them to mean sea level as accepted by the United States engineers and published in professional papers No. 24.

In 1893 to 1895 Assistant C. H. Van Orden of the United States Coast and Geodetic Survey ran two lines of precise levels, one from mean sea level at Boston and the other from mean sea level at Sandy Hook, both connecting with the old Gristmill bench-mark, the former making its elevation 14.07 feet and the latter making it 13.22 feet. The United States Coast and Geodetic Survey has discarded the old elevation 14.73 feet, and now accepts for the elevation of the Gristmill bench-mark the mean of the two lines of levels run between 1893 and 1895, giving for that bench-mark the value 13.64 feet above mean sea level at Sandy Hook. This is the value for the Gristmill bench-mark accepted also by the co-operative topographic survey.

Connection has been made between the levels of State canals west of Rome with the benches of the United States engineer corps at Charlotte and Oswego. The latter was done with the greater care and as a result the canal levels were found to be 0.641 feet below those of the engineer corps.

In order, therefore, to reduce the elevations of the State canals as published by the State Engineer and Surveyor, to mean sea level at Sandy Hook, as obtained from the more recent precise levels and the connections at Oswego, the value 0.1 foot must be added to all such published elevations of bench-marks east of Rome and the value 0.444 feet must be subtracted from all published elevations of the State Canal bench-marks west of Rome.

To reduce the published elevations of the United States engineer corps to mean sea level at Sandy Hook in accordance with the more recent precise levels of the United States Coast and Geodetic Survey the value 1.085 must be subtracted from all elevations of bench-marks published in Professional Papers No. 24.

SPIRIT LEVELING.

The spirit leveling during the past two seasons, like the primary triangulation, has been conducted in accordance with general instructions issued with a view to obtaining a uniform grade of accuracy, and a limit of error of closure at connecting points has been established in order to fix the quality of this work. For the benefit of those who may be interested in the methods adopted for performing such work, their attention is called to the types of bench-marks established as described elsewhere in this report, and to the following instructions issued to levelmen.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY.

INSTRUCTIONS FOR LEVELING.

1. Primary level lines should be run with one or two rodmen and one levelman, and when necessary a bubble-tender. Where such lines are run in circuits which will check back upon themselves or other lines, one rodman will suffice. Where long, unchecked lines are run, two rodmen must be employed.

2. Single-Rodded Lines.— Levelman and rodman must keep separate notes and compute differences of elevation immediately. As levelman and rodman pass, the former must read the rod himself, record and compare readings, then compute the H. I., and after computations are made compare results with the rodman. No comparisons should be made until the record is complete. If the results differ, each must read the rod before comparing anything but results.

3. Work on primary lines should not be carried on during high winds or when the air is "boiling" badly. During very hot weather an effort should be made to get to work early and remain out late, rather than to work during midday.

4. Fore and back sights should be of equal length, and no sight over 300 feet should be taken excepting under unavoidable circumstances, as in crossing rivers at fords or ferries or in crossing ravines. In such cases extraordinary precautions must be taken, as repeated readings at changed positions of rod and level, etc.

5. If it is impracticable to take equal fore and back sights, as soon as the steep slope is passed take enough unequal sights to make each set balance. In this case extra care must be taken to insure correct adjustment of the level.

6. Distances along a railroad can be obtained by counting rails; at other times stadia or pacing may be used, according to the quality of the work. The distances in feet of both the fore and back sights must be recorded in both note-books in the proper columns.

7. Always level the instrument exactly before setting the target. After setting it and before giving the signal "all right" examine the level bubble. If found to be away from center, correct it and reset target.

8. The level must be adjusted daily or oftener, if necessary. The adjustment of the line of collimation and of the level tube is especially important.

9. Provide rodmen with conical steel pegs, 6 to 12 inches long, with round heads, to be used as turning-points. Never take turning-points on rails, ties or between them. Always drive the pegs firmly into the ground.

10. When the rod is lengthened beyond 6.5 feet, both the rodman and the levelman must examine the setting of the target as well as the reading of the rod vernier. When the rod is closed see that the rod vernier indicates 6.5 feet, not depending upon the abutting end to bring it back to place. Keep the lower end of the rod and the top of the turning-point free from mud and dirt.

11. Plumbing-levels must always be used and kept in adjustment, and long extensions of the rod avoided.

12. Leave temporary bench-marks at frequent intervals, marked so that they can be easily identified. These may be on a solid rock well marked, a nail driven in the root of a tree or post, or on any place where the mark will not be disturbed for a few weeks. One such bench-mark should be left for every mile run, in order to give sufficient points to which to tie future levels. Mark in large figures in a conspicuous place when possible the elevation to the

nearest foot. Make notes opposite all elevations at crossings of roads, railroads, streams, bridges, and in front of railway stations and public buildings, and of such other facts as may aid the topographer in his work.

13. All permanent bench-marks must be on copper bolts or bronze tablets let in drill holes in masonry structures or in solid rock, or be on the iron posts adopted by this survey. The figures of elevation must be stamped well into the metal, to the nearest foot only, also name or initial letter of the central datum point.

14. A complete description, accompanied by a large-scale sketch, must be made of each bench-mark, giving its exact elevation as computed from the mean of the two sets of notes. After bench-marks are stamped both levelman and rodman must examine them, and record in note-books the figures stamped thereon.

15. The limit of error in feet should not exceed $.05 \sqrt{\text{distance}}$ in miles.

16. Use the regular survey level-books; keep full descriptive notes on title-page of every book, giving names, dates, etc. Each man should be responsible for his own note-book; and under no circumstances should erasures be made, a single pencil line being drawn through erroneous records.

17. When errors are discovered as the work progresses report the same at once to the topographer in charge.

18. Keep each set of notes separately and independently as taken, paying no attention whatever to other notes except to compare results. If on comparison errors are discovered, correct them only by new observations or computations. All notes must be recorded directly in note-book. Separate pieces of paper for figuring or temporary records must not, under any circumstances, be used.

19. In long, single-rodded lines makes two target settings on each turning-point, by first signaling " up " or " down " to a setting, which is recorded by the rodman, then unclamping and signaling in the opposite direction to a setting. If the two differ more than .002 of a foot, additional readings must be made. The rodman should record all readings, using in his computations only the first of the pair adopted, and the levelman the last.

20. Double-Rodded Lines. — In running unchecked or single primary lines with two rodmen, they should set on turning-points 10 to 20 feet apart, but each at equal distances for fore and back sights; otherwise the above instructions are to be followed with the following modifications.

21. The tripod clamping screws should be loosened when the instrument is set, and tightened only after the legs are firmly planted, and the instrument must be shaded at all times by the bubble-tender.

22. The laborer should place the steel turning-points for fore sights and then return and not remove the back-sight points until the levelman has set targets on the new fore sight, so that there shall be in the ground at all times two turning-points, the elevations of which are known.

23. Bench-marks left at termination of work at night, or for rain or other cause, should be practically turning-points in a continuous line. They should consist of large wooden pegs driven below the surface of the ground, with a copper nail firmly embedded in the top. One of these pegs is to be used as the final turning-point for each rodman. They are to be covered with dirt or otherwise hidden, their location being marked by sketches in note-books showing relation to railroad ties, telegraph poles, etc.

24. An index book or list of bench-marks must be kept posted in the field, in ink, for all classes of leveling done. In these, location sketches of permanent bench-marks may be made, and descriptions should in every case refer, with distance, to some village, section corner, or other place of local importance. All circuit closure errors should be distinctly noted, with cross-reference by page to the connecting lines.

CHAS. D. WALCOTT,

Director.

February 15, 1897.

As an indication of the accuracy obtained in this work, the results of closures of circuits are tabulated below so as to show the distribution of the leveling parties, the localities of the work, and the lengths in miles of all circuits closed with their closure errors in feet. This table includes not only the work of the past field season but also that of the field season of 1896.

1896.

Localities of work, lengths of closed circuits, closure errors and levelmen.

LOCALITY.	Length of circuit.	Closure error.	Levelman.
	Miles.	*Feet.*	
Adirondacks	57	0.021	Clark Brown.
Adirondacks	90	0.041	Clark Brown.
Adirondacks	53	0.125	Clark Brown.
Adirondacks	78	0.145	Clark Brown.
Adirondacks	57	0.166	Clark Brown.
Adirondacks	80	0.020	Clark Brown.
Adirondacks	69	0.016	A. F. Krause.
Adirondacks	85	0.020	A. F. Krause.
Adirondacks	48	0.039	A. F. Krause.
Utica	35	0.042	A. B. Pomme.
Utica	23	0.050	A. B. Pomme.
Auburn	30	0.232	A. B. Pomme and E. L. McNair.
Auburn	35	0.911	A. B. Pomme and E. L. McNair.
Auburn	29	0.027	A. B. Pomme and E. L. McNair.
Skaneateles	45	0.395	A. B. Pomme.
Skaneateles	44	0 110	A. B. Pomme.
Moravia	35	0.607	A. B. Pomme.
Moravia	45	0.683	A. B. Pomme.
Lockport	13	0.198	E. L. McNair.
Lockport	17.5	0 051	E. L. McNair.
Medina	4.5	0.610	E. L. McNair.
Medina	7.5	0.371	E. L. McNair.
Medina	8.5	0.241	E. L. McNair.
Oak Orchard	5.5	0.040	E. L. McNair.
Oak Orchard	5.5	0.009	E. L. McNair.
Oak Orchard	4	0.128	E. L. McNair.
Olean	38	0.168	E. L. McNair.
Olean	5.5	0.019	E. L. McNair.

1897.

LOCALITY.	Length of circuit.	Closure error.	Levelman.
	Miles.	*Feet.*	
Brockport	29	0.203	E. L. McNair.
Salamanca	33	0.142	E. L. McNair.
Tully	37	0.321	Clark Brown.
Tully	48	0.343	Clark Brown.
Cazenovia	57	0.323	Clark Brown.
Remsen	32	0.247	E. L. McNair.
Hempstead	21	0.010	Clark Brown.
Oyster Bay	31	0.032	Clark Brown.

ELEVATIONS FROM SPIRIT LEVELING.

In the following lists of elevations all of the closed circuits have been adjusted and the closure errors distributed. Most of the leveling done in the Adirondack regions is in long, continuous and unchecked lines which will make closures with other circuits in the course of one or two more seasons of work, when adjustment corrections will have to be applied to the published elevations.

Genesee and Monroe Counties.

BROCKPORT AND HAMLIN QUADRANGLES.

The elevations published in the following list are based on a bronze tablet set in the foundation wall of the Normal school at Brockport and marked "U. S. Geological Survey. B. M. Elevation above sea, 538 feet. Datum, B." The elevation of this benchmark above mean sea level is derived from the nearest benchmark of the State canals. As reduced in accordance with the latest information. The height of this benchmark is accepted as 538.210 feet above mean sea level. The elevations accepted for and stamped on the benchmarks of this season are nearly 2 feet lower than those stamped on the adjacent benchmarks placed during the past season, and for this reason the change in datum was made from Lockport to Brockport. The published elevations of the past season are, however, in accord with those published herewith. The leveling was under the direction of Messrs. J. H. Jennings and E. B. Clark, topographers, by Mr. E. L. McNair, levelman.

BROCKPORT TO HAMLIN.

Brockport, west side of street at northwest corner of intersection of streets in front of house of J. Minot; chiseled square on sidewalk slab at gate.......... 498.4

Brockport, Normal school; bronze tablet in foundation wall in front of office, marked "538 B".......	538.210
Clarkson, ½ mile south of; stone horse block opposite small yellow house on west side of road chiseled square....................................	449.24
Clarkson, chiseled square on granite boulder near southwest corner of Hixson's brick store at northeast corner of intersection of roads...............	427.24
Clarkson, .9 miles north of; chiseled square on top of boulder in line with row of maple trees west of road in front of red barn north of white house....	379.16
Clarkson, 2 miles north of at stream crossing; chiseled square on south abutment of bridge.............	353.72
Clarkson, 2.8 miles north of; hard head boulder in fence line west of road, 15 feet south of small stream and opposite bridge over same; chiseled square....	344.35
Hamlin, .9 mile south of; chiseled square on stone abutment southwest corner of small iron bridge....	333.10
Hamlin, Hamlin house, 6 feet from southwest corner of; iron post set in ground inside fence, marked "337 Ft. B"................................	336.677
East Hamlin, .4 mile north of corner which is 1.6 miles east of; floor of iron bridge...............	274.9
Hamlin, top of rail at road crossing R., W. & O. R. R.	306.7

HAMLIN TO HILTON.

Hamlin, 0.8 miles north of, at forks of road; chiseled square on large boulder north end of stone wall, west side of road	306.23

Hamlin, 1.3 miles north of at intersection of roads at schoolhouse; chiseled square on boulder in west end of stone wall at northeast corner of roads.....	305.29
Hamlin, 2.11 miles northeast of; chiseled square on hardhead boulder beside barnyard fence 200 feet west of brick house on north side of road..........	308.91
Hamlin, 3.2 miles east of; chiseled square on granite boulder north of road nearly opposite white house; there are numerous boulders just west of B. M. and an orchard on the north........................	282.75
Hamlin, 4.2 miles northeast of and 1 mile north of East Hamlin; chiseled square on granite boulder just outside of fence in front of brick house on northwest corner of road intersection............	289.42
East Hamlin, 2.4 miles northeast of; chiseled square on boulder under maple tree in front of wood colored house on north side of road at bend to southeast..	289.59
Hilton, 2.5 miles northwest of; chiseled square on western of two large boulders close together on north side of road opposite road from the south.....	288.55
Hilton, ½ mile north of at "Bartletts Corners;" chiseled square on boulder in grass triangle at south east corner of road intersection; a cobblestone church on northeast corner.....................	276.48
Hilton, North Parma hotel, northeast corner of; chiseled square on paving stone 2 feet from telegraph pole	280.65
Hilton, house of Dr. J. J. Williams; bronze tablet set in foundation wall under bay window, marked "284 Ft. B"	284.219

HILTON TO SPENCERPORT.

Hilton, 1.4 miles south of; at North Parma; chiseled square at southwest corner of stone walk in front of house on northeast corner of road intersection.....	298.84
Parma Center, 250 feet south of store; chiseled square on large round boulder near foot-path on west side of road	344.11
Parma Center, .9 mile south of; chiseled square on boulder northeast corner of road intersection at house without blinds	351.67
Parma Center, 2.1 miles south of; chiseled square on hard head boulder in old fence line on west of road nearly in front of a light gray house with light blue blinds	351.67
Parma Corners, chiseled square on flat stone at northwest corner of building standing on the southeast corner of intersection of Ridge road..............	433.52
Spencerport, Amity street; lower step of west wing of westernmost of two canal bridges (this is Erie canal benchmark)	512.65
Spencerport, Amity street; canal bridge No. 99; bronze tablet in center of abutment facing towpath and canal, marked "514 Ft. B".................	513.700
Spencerport, N. Y. C. & H. R. R. R. station; southeast corner of doorstep at east end of building..........	527.91
Spencerport, base of rail at east end of N. Y. C. & H. R. R. R. station....................................	524.8

BROCKPORT TO SWEDEN.

Brockport; Erie canal benchmark No. 107 on lower step, east end; towpath abutment of Park avenue canal bridge....................................	510.669

Brockport, Park avenue and South street; top of spindle of hydrant.............................. 530.23

Brockport, MacLachlan's coal-yard; chiseled cross on sandstone in front of office....................... 544.17

Brockport, chiseled cross on sandstone about 75 feet south of hydrant on west side of Main street near top of hill, ¼ mile south of railroad................ 557.39

Brockport water tower; chiseled square on stone foundation, west side.............................. 606.81

Brockport, 1 mile south of; chiseled square in stone horse block step in front of white house west side of road at top of hill opposite cemetery............ 686.99

Brockport, 4.6 miles west of, on northeast corner of coping northwest abutment of N. Y. C. & H. R. R. R. bridge No. 136............................... 527.89

Brockport, ½ mile east of; white paint mark on corner of coping east side N. Y. C. & H. R. R. R. stone culvert No. 125, south side of track................. 533.51

SWEDEN TO BERGEN.

Sweden Center, chiseled square on boulder on west side of road in front of first house north of brick church 667.74

Sweden Center, .7 mile south of; chiseled square on limestone ledge west side of road 50 feet from small wooden bridge and 400 feet south of stone house... 618.55

Sweden Center, 1 mile south of; chiseled square on boulder at northwest corner of intersection of roads. 634.97

Sweden Center, 1 mile south of, at George H. Way's residence; bronze tablet in foundation wall under bay window, marked "639 Ft. B."................ 639.170

Bergen, 1½ miles north of; on abutment west side south end of bridge over Black creek..............	574.7
Bergen, West Shore Railroad crossing; top of rail....	579.4
Bergen, N. Y. C. & H. R. R. R. station; top of rail...	603.1
Bergen, N. Y. C. & H. R. R. R. station; bronze tablet, set in doorstep of baggage-room, marked "604 Ft. B."	603.938

SOUTHWARD FROM CHILI STATION ON N. Y. C. & H. R. R. R.

Chili, waterpass abutment on line of N. Y. C. & H. R. R. R. 9,200 feet east of station....................	563.76
Chili Station, 380 feet east of; bronze tablet, set in south end of old culvert abutment at southwest corner of flagman's shanty, south side of main line N. Y. C. & H. R. R. R., marked "561 Ft. B".......	561.154
Chili station, 1.2 miles south of; chiseled square on stone abutment northwest corner of iron bridge over Black creek just south of Buckbee's Corners.......	534.99
Chili station, 2 miles south of; chiseled square on boulder north side of driveway leading into barn on west side of road 150 feet south of white house..........	565.14
Chili station, 2½ miles south of, and 1¼ miles south of Buckbee's Corners; bronze tablet, in foundation wall under southeast corner of dwelling house of John Groves, on west side of road, marked "559 Ft. B."	558.450

CHURCHVILLE TO ADAMS BASIN.

Churchville, N. Y. C. & H. R. R. R. station; base of rail opposite center of building..................	567.5

Churchville, ½ mile north of; floor of iron bridge over Black creek	565.1
Churchville, top of rail, West Shore Railroad crossing.	568.6
Adams Basin, eastern doorsill of railroad station.....	524.52
Churchville, Union School building; bronze tablet, at right side of main entrance, marked "615 Ft. B."..	614.612
Churchville, N. Y. C. & H. R. R. R. station; 800 feet east of; west abutment N. Y. C. & H. R. R. R. bridge No. 721 (R. R. Co.'s benchmark)..................	563.55
South Chili, .7 mile west of, on road to Riga Center; red mark on rock at road intersection.............	607.

CATTERAUGUS COUNTY.

SALAMANCA QUADRANGLE.

The elevations published in the following lists are based on a bronze tablet, set in brick school house No. 4, on Maple street, Salamanca, and marked "U. S. Geological Survey. B. N. Elevation above sea, 1396 Ft. Datum S." The elevation of this benchmark above mean sea level is based on the top of rail in front of the center of W. N. Y. & P. R. R. station in Olean and is the same as that accepted for the leveling in this region done during the previous field season, and is 1,434.143 feet, the datum being changed from Olean to Salamanca because of a difference of nearly two feet which was discovered at the close of the previous field season and in consequence of which the adjacent benchmarks placed during that season are marked 2 feet higher than their accepted and published elevations, and the elevations of the bench-marks established during the last season. The leveling was done under the general direction of Mr. J. H. Jennings, topographer, by Mr. E. L. McNair, levelman.

OLEAN, VIA ALLEGANY AND VANDALIA TO CARROLTON.

Olean, public school No. 2 (brick structure) on south side of State street; chiseled square on northwest corner of stone step at entrance..................	1,431.16
Olean city building, 2.16 miles northwest of; chiseled square on south end of stone culvert, east side, over small stream	1,420.92
St. Bonaventure College, ½ mile west of; chiseled square on boulder at southwest corner of intersection of roads..................................	1,429.18
Allegany, iron bridge over Five Mile creek; chiseled square on foundation abutment..................	1,416.12
Allegany, 1½ miles west of; bronze tablet, in next to top step at south end and west side of stone arch culvert under Erie Railway, marked "1415 Ft. S"..	1,414.570
Allegany, 2½ miles west of; chiseled square north end of small stone culvert under highway.............	1,413.28
Allegany, 3.5 miles west of; chiseled square on flat stone under northwest corner of wood colored barn near road on south side.........................	1,483.97
Vandalia station, iron highway bridge near; chiseled square on stone abutment at southeast corner....	1,407.51
Vandalia, 1.1 miles west of; chiseled square on small boulder at north side of plank bridge about 5 feet west of watering trough and 30 feet south of spring.	1,437.26
Vandalia, 2.7 miles west of; chiseled square on large flat slab in slanting position on north side of road between telephone poles No. 6,442 and 6,443.......	1,433.33
Vandalia, 3.5 miles west of; chiseled square on large boulder north side of road about 125 feet west of road south to Limestone and Bradford...........	1,407.67

South Vandalia Southward through Chipmunk Oil Fields.

South Vandalia station, ½ mile south of; chiseled square on large flat stone in front yard of white farm house west side of road....................	1,410 30
South Vandalia station, 2.7 miles south of; chiseled square on boulder in ditch on west side of road nearly opposite schoolhouse....................	1,451.86
South Vandalia station, 3 miles south of; copper bolt in boulder 2 feet outside fence on west side road, 55 feet south of road east and 140 feet north of N. Kelly's white house on west side of road, bolt is marked "1529 Ft. S."..........................	1,528.794
Knapps Creek, top of rail in front of electric railroad station	2,346.8

Carrolton via Limestone to State Line New York and Pennsylvania.

Carrolton, ¾ mile east of; chiseled square on large boulder west side of road about 25 feet from northwest corner of iron bridge over slough............	1,392.68
Carrolton, 2 miles south of; iron highway bridge crossing Allegany river, chiseled square on bridge abutment about 8 feet from southwest corner.....	1,401.83
Allegany river iron highway bridge, .83 mile south of, and 4 miles north of Limestone; copper bolt, in large boulder nearly buried in ground on west side of road between it and ditch, pole bars answering pasture fields on each side of road; bolt marked "1410 Ft. S."..................................	1,410.368
Limestone, 3 miles north of and 75 feet west of road going up Rice creek; chiseled square on boulder in ploughed field east side of road.................	1,405.01

Limestone, [illegible] miles north of, chiseled square on large boulder, east side of road about [illegible] feet from wagon track between telegraph poles [illegible] and [illegible] [illegible]

Limestone, [illegible] mile west of, chiseled square on small boulder [illegible] feet from fence corner, northwest corner of intersection of roads ... [illegible]

Limestone, [illegible] miles southwest of, [illegible] in root of maple tree, east of road between telephone poles [illegible] and [illegible] ... [illegible]

Limestone, [illegible] miles southwest of, chiseled square on top of State line monument on west side of road near [illegible], opposite telephone pole No. [illegible] ..... [illegible]

Limestone, [illegible] miles southwest of, [illegible] in small projecting root of large elm tree [illegible] feet [illegible] of northwest corner of large iron bridge over stream just inside Pennsylvania State line .... [illegible]

Limestone, [illegible] miles north of, chiseled square on stone abutment [illegible] feet from southwest corner of iron bridge over stream just inside Pennsylvania State line .... [illegible]

Limestone, [illegible] miles north of iron bridge described in last-named [illegible]; chiseled square on stone abutment [illegible] feet from southeast corner of bridge .. [illegible]

Limestone, [illegible] miles west of, on road to [illegible], [illegible] of bridge .... [illegible]

[illegible]

Carrollton, [illegible] chiseled square on north abutment of large iron bridge, east side of track .... [illegible]

Carrollton, [illegible] miles northwest of, chiseled square on large boulder [illegible] at northeast corner of intersection of roads .... [illegible]

Carrolton, 2.86 miles northwest of; chiseled square on rock at northwest corner of small wooden bridge near road from northeast	1,394.44
Carrolton, 3.92 miles northwest of; chiseled square on rock at north end of stone bridge or culvert in highway	1,393.68
Kill Buck, chiseled square on rock at northwest corner of road intersection near telephone pole	1,428.03
Kill Buck, 1.25 miles west of; chiseled square on rock south side of road next to footwalk, opposite small white house south of road	1,415.19
Salamanca, nearly opposite Main street; chiseled square on small stone east side of crosswalk in road	1,423.82

SALAMANCA TO RED HOUSE.

Salamanca, opposite First National Bank; chiseled square on corner of curbstone one foot from telephone pole	1,387.88
Salamanca, Maple street; brick schoolhouse No. 4; bronze tablet, in water table at west side of front entrance, marked "1396 Ft. S"	1,396,130
West Salamanca, near iron highway bridge across Allegany river; chiseled square on stone horse block on west side of road in front of square white house	1,381.82
West Salamanca, top of rail N. Y., P. & O. R. R., opposite station	1,376.2
West Salamanca, 7 miles north of; floor of iron bridge across Little Valley creek	1,397.4
West Salamanca, 1 mile north of; top of rail at crossing of Erie railroad	1,404.4
West Salamanca, 3.3 miles north of; floor of iron bridge over Little Valley creek	1,481.6

West Salamanca, 3.7 miles north of; floor of iron bridge over Little Valley creek.................... 1,495.2

Little Valley Centre, .4 mile north of; floor of iron bridge over Little Valley creek.................... 1,481.6

Little Valley Centre, 2.4 miles north of; floor of iron bridge over Little Valley creek.................... 1,538.4

Salamanca, 2.5 miles west of; chiseled square on highest point of irregularly shaped boulder just opposite small wood colored house south of road........... 1,377.89

Salamanca, 3.5 miles west of; wire nail in root of elm tree west of road, opposite church on east side of road 1,371.04

Red House, 3.5 miles north of; tack in root of maple tree on west side of road, 15 feet south of another maple and 75 feet north of small wooden bridge.... 1,367.83

Red House, 2.6 miles north of; chiseled square on small flat rock beside gate post in front of small white house on east side of road occupied by Indian family. River bank close to west side of road.............. 1,357.57

Red House, large iron highway bridge across Allegany river, chiseled square on lower step of bridge abutment at northeast corner........................ 1,348.55

Red House, W. N. Y. & P. R. R., top of rail opposite station 1,350.5

Red House, 3 miles east of, toward Halls; floor of small wooden bridge near cross roads.................. 1,404.8

Red House, 4.3 miles east of, toward Halls; floor of iron bridge over Red House creek.................... 1,456.1

Red House, 5.9 miles southeast of, on road to Halls; bolt southwest corner of iron bridge over Red House creek 1,565.5

KILL BUCK TO GREAT VALLEY.

Kill Buck, .93 mile north of; chiseled square on small flat stone in center of gateway in front of weather stained house on east side of road at forks of road...	1,402.26
Kill Buck, 2 miles north of; chiseled square in front of large flat stone doorstep in front of front door of 1½-story house on north side of road and about 200 feet north of iron bridge over Great Valley creek...	1,428.65
Kill Buck, 3.15 miles north of; chiseled square on stone abutment at southeast corner of iron bridge across Great Valley creek	1,435.70
Kill Buck, 3.9 miles north of; copper bolt in stone abutment at southwest corner of iron bridge across Wright's creek about ¼ mile above its junction with Great Valley creek; bolt is marked "1,456 Ft. S"	1,456.578
Great Valley, iron bridge across Great Valley creek; bridge abutment at northeast corner.............	1,469.14
Great Valley, 1.7 miles north of and 3 miles south of Ellicottville; chiseled square on foundation stone under post 14 feet south of northeast corner of C. B. Potter's barn; a road crosses B. R. & P. Ry. and creek between barn and house...............	1,521.01

GREAT VALLEY TO HUMPHREY.

Great Valley, 1.3 miles south of; chiseled square on stone horse block north of road in front of yellow house	1,523.99
Great Valley, 2.52 miles southeast of; chiseled square on stone abutment northwest corner of iron bridge across Wright's creek, near a white church........	1,518.26

Humphrey, 2.7 miles west of; chiseled square on north end of stone masonry around end of sewer pipe culvert under highway	1,533.35
Humphrey, 1.7 miles west of; chiseled square on stone abutment 4 feet from southeast corner of iron bridge across Wright's creek	1,553.63
Humphrey, 1 mile west of; chiseled square on boulder at southeast corner of small wooden bridge on north and south road and about 75 feet south of the road running east and west to Humphrey	1,581.34
Humphrey, W. J. Sherman's hotel; copper bolt in stone doorstep in front of porch, west side, marked "1,626 Ft. S"	1,626.099
Humphrey, .3 mile northeast of; floor of wooden bridge	1,626.3
Humphrey, .9 mile northeast of; floor of wooden bridge	1,625.4
Humphrey, 1.8 miles north of; floor of small wooden bridge near unpainted house	1,674.9
Humphrey Center, 1 mile northeast of; floor of small bridge	1,732.0

HUMPHREY TO ALLEGANY.

Humphrey, 1.5 miles southwest of; chiseled square on large boulder north side of road opposite watering trough and east of road going south	1,657.81
Humphrey, 2.1 miles south of; chiseled square on rock on north side of road beside sluiceway crossing road in front of white house on south side of road	1,903,32
Humphrey, 2.5 miles south of; chiseled square on small boulder on east side of road just south of summit and 20 feet north of telegraph pole	2,187.04

Humphrey, 3.3 miles south of; chiseled square on boulder projecting from bank on south side of road nearly in front of wood colored house	1,983.37
Allegany, 6.5 miles north of; chiseled square on large boulder under butternut tree about 50 feet below bridge over stream and on lowest side of road	1,720.23
Allegany, 5.4 miles north of; iron bolt in top of stone hitching post in front of white house on east side of road	1,556.67
Allegany, 4.6 miles north of; chiseled square on large boulder on west side of road near large white house on same side of road and 200 feet back from road, and opposite wood colored barns at bend in road	1,553.31
Allegany, 3.8 miles north of; chiseled square on stone horse block in front of white house with green blinds on east side of road	1,515.36
Allegany, 3.3 miles north of; chiseled square on stone horse block in front of white house with brown blinds on west side of road	1,517.42
Allegany, 2.5 miles north of; chiseled square on top of small boulder at south end of sluice box under highway at southwest corner of intersection of roads	1,482.90
Allegany, .9 mile north of; chiseled square on stepping stone between two stone posts in front of square wood colored house on west side of road	1,437.49

Onondaga, Madison and Cortland Counties.

CAZENOVIA AND TULLY QUADRANGLES.

The elevations in the following list are based on a copper bolt, which is Erie canal benchmark No. 82, and is set in the southwest corner of the stairway landing pier of the west towpath stairs of

the Geddes street bridge in Syracuse. The elevation of this benchmark is accepted as 405.772 feet above mean sea level as reduced from the latest information relative to precise and State canal levels. The elevations stamped on the benchmarks of this season are about 2 feet lower than the stamping on adjacent benchmarks of the work done during the previous season, owing to corrections in datum as brought through by precise levels from Sandy Hook. The elevations stamped during the past season, however, agree with the published elevations of the previous season, as well as with those published herewith. The leveling was done under the general direction of Messrs. W. M. Beaman, C. C. Bassett and A. M. Walker, topographers, by Mr. Clark Brown, levelman.

SYRACUSE TO SUMMIT VIA ONONDAGA VALLEY, CARDIFF AND TULLY.

Syracuse, Geddes street bridge; Erie canal benchmark No. 82, copper plug at southwest corner of stairway landing, pier at foot of West towpath stairs........	405.772
Syracuse, Grand avenue and Geddes street; top of fire hydrant	405.13
Syracuse, D., L. & W. Ry. station; top of rail.........	388.81
Syracuse, Onondaga avenue, east side of and 200 feet south of Levenworth fountain; top of fire hydrant..	405.59
Syracuse, West Colvin street bridge over Onondaga creek; north end of west abutment, northwest corner of top stone; square chiseled mark............	405.06
Syracuse, southwest corner of West Colvin and South Salina streets; top of fire hydrant................	418.23
Syracuse, northeast corner of South Salina street and Matson avenue; chiseled cross on stone monument.	417.83

East Onondaga; copper bolt, set in coping of northwest wing of bridge over Onondaga creek, marked "U. S. G. S. S 422 Ft. B. M." 421.649

East Onondaga, 1.1 miles south of; chiseled square on center of east coping, highway culvert............ 436.61

Onondaga Castle, ½ mile north of; nail in root of maple tree 18 inches in diameter, southeast corner of road to east.. 469.50

Onondaga Castle, 30 feet north of hotel, 30 feet east of road; chiseled square on well curb................ 519.34

Onondaga Castle, ½ mile south of; base of one-chimney house, east of road, middle of hill descending south. 484.

Onondaga Indian village, opposite 6-mile post; nail in root of 3-foot sycamore tree 40 feet south of brook by west road fence............................ 447.64

Onondaga Indian village, 600 feet south of road leading to west in north end of village; benchmark on basswood tree 3 feet in diameter.................. 453.164

Castle creek, iron bridge; top of southwest anchor bolt 468.70

Onondaga Indian village, ¼ mile south of road leading to South Onondaga, 900 feet south of cemetery and 40 feet south of small brook; copper bolt, in boulder, 3 feet from west road fence, and marked "U. S. G. S. S. 469 Ft. B. M."..................... 468.195

Eight-mile post, 2,500 feet south of, on top of small hill; chiseled square on north edge of rim of casing of water-pipe valve, 12 feet inside of west road fence.. 510.08

Nine-mile post, 20 feet south of, east side of road; root of elm tree 2½ inches in diameter............ 489.76

Solvay water tank, west side of road, opposite tank; chiseled square on north side of rim of valve casing.	567.04
Ten-mile post, 10 feet north of, on east side of road; chiseled square on boulder 3 feet broad............	590.54
Ten-mile post, ½ mile south of, 300 feet north of white house, east side of road; chiseled square on east edge of rim, point of valve case of Solvay water pipe.	613.82
Cardiff, ⅛ mile east of road, back of hotel, 75 feet south of brook; boulder 6 feet broad and 2 feet high; copper bolt, marked "U. S. G. S. S 676 Ft. B. M."......	675.652
Cardiff, 250 feet north of cemetery, on east side of road; nail in top of stump between road and sidewalk..	604.44
Cardiff, 1 mile south of, 400 feet south of Sulphur Well Brook bridge, and about 100 feet south of house; chiseled square on outcrop 5 feet west of road	574.15
Tully Valley, .3 mile north of cross-roads, 25 feet south of bridge; nail in root of elm tree by west road fence	568.29
Tully Valley, 40 feet north of cross-roads; nail in root of maple tree by east road fence..................	604.79
Salt Wells, first summit in road north of; chiseled square on south side of rim of casing of water-pipe valve	637.64
Tully valley, 50 feet north of schoolhouse, 10 feet east of road; chiseled square on boulder..............	648.50
Tully valley, south end of; benchmark on fire hydrant opposite white barn, east of road, 40 feet south of first telegraph pole............................	740.08

Tully valley, south end of, 700 feet north of road west to Vesper, 500 feet south of curve in road, on boulder in southwest corner of barnyard, west side of road, copper bolt, marked "U. S. G. S. S 819 Ft. B. M." 819.047

Tully hillside, 20 feet northeast of first house on west side of road south of salt derricks; boulder 6 feet broad, chiseled square 962.62

Tully hill, 100 feet south of house at top of; nail in root of 15-inch elm tree by east road fence 1,266.40

Tully center, 300 feet east of crossroads; nail in stump 14 inches in diameter, south of road in front of barn. 1,252.36

Tully, 200 feet north of Hotel Slayton; in water table of brick house on west side of road, at southeast corner, front of house, crossmark on bronze tablet, marked "1251 S" 1,251.092

Tully, east side of road leading north opposite Hotel Slayton, fire hydrant near crossroads 1,247.46

Tully, ¾ mile east of, 125 east of road south; nail south side of large maple tree inside of fence on south side of road 1,298.85

SUMMIT TO JAMESVILLE VIA ONATIVIA.

Summit, ¼ mile north of; nail in top of pine stump 700 feet north of road to north, east of five pine trees in row north side of road 1,289.26

Summit, ½ mile north of; chiseled square in flat boulder 10 feet east of road, 10 feet north of schoolhouse 1,273.26

Summit, 1 mile north of on road to Syracuse, 500 feet north of white house on west side of road, 125 feet north of road summit; copper bolt, in boulder, marked "U. S. G. S. 1292 Ft. S B. M." 1,291.904

Onativia, 1¾ miles south of; face corner of parapet, west end, north abutment, 20 foot span farm bridge. 1,088.42

Ontativia, engine water column at railway station; top of anchor bolt in northwest corner of base plate 991.68

Jamesville, 5½ miles south of, 200 feet north of post marked "12 M to Syracuse," opposite sawmill; face corner, north end of retaining wall to railroad embankment.................................. 882.17

Jamesville, 2 miles south of; 20 foot span cattle pass north abutment, east end, face corner of parapet 400 feet north of road crossing D. L. & W. Ry...... 708.27

Jamesville, ¾ mile south of at east end of reservoir dam, in coping; crossmark on bronze tablet marked "S 645"... 644.983

SUMMIT TO DELPHI VIA APULIA AND FABIUS.

Apulia, 300 feet west of schoolhouse, 60 feet west of dwelling, 15 feet from north road fence, 10 feet from wagon track; chiseled square on boulder.... 1,294.13

Apulia, ¼ mile east of; northeast corner of road to northeast, second maple tree, 15 inches in diameter, nail in root.................................. 1,302.93

Apulia, 1 mile east of; ¼ mile east of cemetery and 150 feet west of house; chiseled square on boulder in north road fence........................... 1,294.04

Fabius, 1 mile west of, 50 feet west of summit, 20 feet south of road; nail in root of 18-inch basswood tree.. 1,347.50

Fabius, ¾ mile west of; southeast corner of cross-roads; chiseled square on large boulder 75 feet from intersection 1,302.16

Fabius, ½ mile north of; highest point of flange on upstream end of tile culvert.................... 1,248.74

Fabius, 100 feet west of crossroads, Main and Cemetery streets, in wall under west window of flat-roofed frame house; crossmark on bronze tablet, marked "1284 S"............................ 1,284.036

Delphi, 2 miles west of; block school 25 feet west of crossroads, 5 feet south of road; chiseled square on flat boulder 1,397.269

Delphi, 100 feet west of Main street, 5 feet north of East and West street, in edge of turn around northwest of quadrant; chiseled square on boulder..... 945.086

DELPHI TO JAMESVILLE, VIA ORAN AND MANLIUS.

Delphi, 3 miles north of , at crossroads, at east side of Limestone creek valley; nail of maple tree northeast corner of road intersection................. 806.25

Oran, 1½ miles southeast of, and 1½ miles southeast of railroad crossing of Cherry Valley turnpike; 500 feet northwest of rock cut; chiseled square on north coping of cattle pass....................... 1,091.52

Oran, 1 mile southeast of, about 300 feet south of fork of road opposite long red barn; notched root, west side of 15-inch maple tree on west edge of road.... 889.65

Oran, 300 feet west of church, 20 feet north of road, in prominent boulder; copper bolt, marked "U. S. G. S. S 793 Ft. B. M."............................ 793.148

Buellville, 400 feet northwest of schoolhouse; 15 feet north of road; chiseled square on boulder........ 761.16

Manlius, northeast corner Seneca and Franklin streets; top of fire hydrant..................... 601.99

Manlius, on road to Fayetteville, 50 feet south of fork of road to High bridge; fire hydrant..............	600.10
Manlius, 1½ miles northwest of, at High Bridge; double arch bridge over Limestone creek, in coping 5 feet from end of southwest wing, copper bolt, "U. S. G. S. S 507 Ft. B. M.".....................	507.027
Jamesville, near Dunlap Mills; fire hydrant 100 feet west of bridge and 20 feet south of road...........	548.74
Jamesville, 1 mile northwest of; boulder 6 feet south of railroad track at overhead crossing, 30 feet east of highway bridge; chiseled square...............	586.90

FAYETTEVILLE TO ERIE CANAL.

Fayetteville, 100 feet west of Limestone creek bridge; southwest corner of streets, fire hydrant..........	437.33
Erie canal, Limestone creek aqueduct; southwest coping parapet on west wing, towpath side (canal bench-mark No. 70); copper plug.................	433.666

FABIUS TO CUYLER, VIA KEENEYS' SETTLEMENT.

Fabius, ¾ mile south of; 175 feet north of road to west; chiseled square on boulder east side of road..	1,256.93
Fabius, 1¼ miles south of; nail in root of basswood tree west side of road opposite house.............	1,252.47
Fabius, 1¾ miles south of; iron bridge, east end, south abutment chiseled square.........................	1,229.18
Keeneys Settlement, ½ mile north of; 300 feet north of house, flat boulder, 5 feet broad, 10 feet west of road, chiseled square...........................	1,225.61
Keeneys Settlement, 500 feet east of schoolhouse; iron bridge, top stone northeast wing; chiseled square..	1,208.72

Cuyler, about 2 miles north of, in front of 1½ story white house on east side of road; nail in top of large pine stump 20 feet south of large pine tree........ 1,215.55

Cuyler, 1½ miles north of; 600 feet north of yellow barn on west side of road; nail in root of large crooked triple trunk elm tree, 2½ feet in diameter on west side of road........................... 1,200.23

Cuyler, 1 mile northeast of, chiseled square near end of northeast wing or iron bridge over Tioughnioga creek.................................. 1,205.75

CUYLER TO DERUYTER RESERVOIR, VIA DERUYTER.

Cuyler, ¼ mile east of; 500 feet east of north and south road, 4 feet south of Lehigh Valley Railroad track; copper bolt, in boulder, marked "U. S. G. S. 1256 Ft. S. B. M.".............................. 1,256.750

Cuyler, ¼ mile south of, 500 feet east of north and south road, 4 feet south of Lehigh Valley Railroad track, in same boulder as described in last above, railroad bench-mark No. 86‴, iron bolt........... 1,256.95

Cuyler, 2 miles northeast of, 300 feet west of trestle, 600 feet west of schoolhouse, 20 feet north of railroad track; railroad spike driven in side of 18 inch maple stump................................ 1,305.93

Deruyter, 1¾ miles west of; ¼ mile east of schoolhouse 100 feet north of railroad crossing, 20 feet north of farm crossing; railroad spike driven in root of maple tree 2 feet in diameter (Railroad bench-mark No. 88′).................................. 1,306.80

Deruyter, foundation of water tank; iron bolt set in coping side next to railroad track................ 1,284.17

Deruyter, ½ mile north of; intersection of Fabius and Cazenovia roads; nail in root of maple tree 2½ feet in diameter in fork of road........................ 1,289.45

Deruyter, 1½ miles north of; 20 feet south of iron bridge, on west side of road; limestone boulder marked with chiseled square...................... 1,329.83

Deruyter, 2 miles north of; iron bridge on road to reservoir, east end, south abutment, chiseled square on corner 1½ feet below bridge seat............... 1,304.70

Deruyter, 2¾ miles north of; iron bridge over feeder to Deruyter reservoir, southeast wing, south corner; chiseled square 1,317.94

Deruyter reservoir dam, west end of dam, south parapet of spillway arch, east end, face corner of coping; copper bolt marked "1286 Ft. S."................ 1,286.088

Deruyter to Erieville, via Sheas Corner and Georgetown.

Deruyter, 2½ miles north of; railroad bench-mark No. 92, ½ mile east of Reservoir road, opposite old sawmill, railroad culvert, south parapet; iron bolt set in lead 1,318.59

Sheds Corner Station, 1 mile south of, 1 mile east of Reservoir road, 700 feet east of road crossing, 200 feet west of short deep cut; railroad spike in root of large elm on south bank of creek............... 1,334.35

Sheds Corner Station, railroad bench-mark No. 94, 600 feet south of Tioughnioga creek railroad bridge, north abutment, west end, parapet; iron bolt set in cement 1,385.55

Sheds Corner Station, 600 feet south of; railroad bridge over Tioughnioga creek; bridge seat, west end, south abutment; copper bolt, marked "U. S. G. S. 1383 Ft. S. B.M." 1,383.86

Sheds Corner, iron bridge near church, nail in top of 12 inch pile at east end of north abutment. 1,414.34

Sheds Corner, 1 mile southeast of; northwest corner of road west; nail in root of maple tree 3½ feet in diameter 1,476.85

Sheds Corner, 1¾ miles southeast of; northeast corner of road east; nail in root of elm tree 2½ feet in diameter 1,538.69

Tioughnioga creek, ¼ mile southeast of; wild black cherry tree 50 feet from fork of road in angle; nail in notched root. 1,609.15

Georgetown, 2 miles northwest of, opposite sawmill; nail in root of cherry tree 2½ feet in diameter, 10 feet east of road. 1,592.76

Georgetown, 1½ miles northwest of on road to Sheds Corners, 75 feet north of road to Erieville, 20 feet north of brook, 15 feet west of road, 4 feet east of road fence, iron bench-mark post with bronze cap, marked "S 1538". 1,538.276

Erieville, 3 miles south of, and 1 mile north of railroad, at summit of hill; nail in root north side of maple tree east side of drive to house, 20 feet north of road. 1,764.83

Erieville, 1¼ miles south of; 500 feet north of 30 mile post, nail in root of large elm tree 20 feet west of track 1,624.85

Erieville, railroad bridge over road south of; chiseled square on top stone, south end, west abutment. 1,618.63

Erieville, railroad culvert at station; chiseled square northeast corner of coping east end............... 1,569.58

ERIEVILLE TO ORAN VIA FENNER AND CAZENOVIA.

Erieville reservoir gatehouse, 6 feet west of door; copper bolt, in projection of bottom course, marked "U S. G. G. 1473 Ft. S. B. M."..................... 1,473.647

Erieville, 2 miles north of; 300 feet southwest of houses and south of three large elm trees; nail in root of 30 inch elm near east road fence.......... 1,447.95

Nelson, 1½ miles south of; notch in root of maple tree 20 feet east of road, opposite northeast corner of cemetery 1,536.35

Nelson, ¾ mile south of; north of summit, chiseled square on boulder, west edge of road............. 1,541.90

Nelson, 500 feet south of crossroads; chiseled square on face corner of bottom stone, east end, north abutment of bridge 1,431.78

Nelson, 1 mile north of; 400 feet north of road to west, opposite barn on west side of road; boulder 10 feet east of road, marked with chiseled square.. 1,450.88

Nelson, 1½ miles north of; at crossroads; chiseled square on boulder at northeast corner of road...... 1,433.67

Fenner, 1 mile south of and 1,000 feet north of Peterboro turnpike, 150 feet south of orchard, 75 feet west of road; in outcrop; copper bolt, marked "U. S. G. S. 1,466 Ft. S. B. M."...................... 1,467.080

Fenner, 1½ miles south of, at crossroads; notched root of 30-inch elm in southwest corner.......... 1,466.94

Cazenovia, 2¾ miles east of; southeast corner of road to southeast; chiseled square on boulder.......... 1,403.50

Cazenovia, 942 feet south of L. V. R. R. depot; railroad benchmark No. 103; iron pin in northwest corner of north abutment	1,187.18
Cazenovia, Chapel building of seminary; water table under pilaster at east side of door, south entrance of chapel; crossmark on bronze tablet marked "S 1,246"	1,246.859
Cazenovia, West Shore railroad pumping station; foundation of water tank, north pedestal next to track; chiseled square	1,196.46
Cazenovia, 1¼ miles northwest of West Shore railroad depot, in schoolhouse grounds; nail in root of 3 foot elm tree, 40 feet south of school	1,328.39
Cazenovia, 2 miles northwest of West Shore railroad depot, over tunnel; highest point of stone monument 40 feet north of road	1,264.61

Oneida, Herkimer and Hamilton Counties.

REMSEN, WILMURT, OLD FORGE AND MCKEEVER QUADRANGLES.

The elevations published in the following list are based on a bronze tablet set in the north end of the retaining wall between the lower mill dam and the Rome, Watertown and Ogdensburg railroad in Remsen, and marked "U. S. Geological Survey B. M. Elevation above sea, 1,172 feet. Datum R." The elevation of this benchmark above mean sea level is obtained from the elevation of the permanent benchmark established at South Trenton during the preceding field season, the height of which is accepted as 804.368 feet above mean sea level, as reduced in accordance with the latest information through precise leveling to Albany from Sandy Hook and the levels of the State canals. In accordance with these connections the elevation of the Remsen benchmark

is accepted as 1,171.873 feet above mean sea level. The datum was changed to Remsen, from that of Utica, accepted for adjacent leveling of the preceding season, because the benchmarks established on the Utica quadrangle are stamped 2 feet higher than those established during this season, though the elevations of these Utica benchmarks were published in accordance with the latest corrections and on the same datum as are the elevations published herewith. The leveling was done under the general direction of Messrs. J. H. Jennings, W. H. Lovell, and C. C. Bassett, topographers, by Messrs. Clark Brown and E. L. McNair, levelmen.

TRENTON VIA PROSPECT, HINCKLEY, NORTHWOOD TO NEAR WILMURT AND THENCE VIA OHIO TO COLD BROOK.

South Trenton, ½ mile north of; chiseled square on boulder, west side of road 20 feet south of large elm tree	826.95
Trenton, .78 mile south of; chiseled square on stone step in front of porch of new house at southwest corner of intersection of roads	796.01
Trenton, R., W. & O. R. R. station; water table .42 feet west of door jamb, south door of waiting room.	841.07
Trenton, .7 mile north of station; top of iron bolt in top of northernmost of two stone hitching posts 25 feet apart on west side of road and opposite road turning east	798.05
Trenton, 1.1 miles north of station; iron bolt in top of easternmost of two stone hitching posts 50 feet apart north side of street on road to Prospect......	780.61
Trenton, 2 miles north of station; chiseled square on east end of stone wall in front of white house on north side of road	870.60

Prospect station, R., W. & O. R. R. crossing over highway just north of; chiseled square on lower step of south abutment, east side	985.35
Prospect station, R., W. & O. R. R., .4 mile north of; chiseled square on granite boulder north side of road 340 feet east of Mohawk and Malone railroad crossing	1,086.76
Prospect, iron bolt in top of stone hitching post in front of post-office opposite street going east to Hinckley	1,188.47
Prospect post-office, .22 mile north of; copper bolt in large boulder 3 feet high, 12 feet long and 7 feet wide, in field opposite creamery and east of road; bolt is marked "1142 Ft. R."	1,141.520
Prospect, .4 mile east of; chiseled square on boulder north side of road 22 feet from corner of red painted building (pump factory)	1,210.29
Prospect, 1.3 miles east of; chiseled square on lower step, in line of stone wall in front of white house on north side of road	1,216.20
Hinckley, ¼ mile west of Empire Hotel; chiseled square on east end of wall of stone culvert, north side of road	1,181.45
Hinckley, .6 mile east of Empire Hotel; chiseled square on small boulder deeply embedded in ground, west side of road close to wagon track	1,194.43
Hinckley, State bench-mark west of road painted "B. M. No. 63"	1,183.29
Hinckley, 2 miles north of; chiseled square on small boulder, east side of road close to two maple trees	1,254.77

Hinckley, 2.3 miles northeast of, and about 1.1 miles west of Oneida-Herkimer county line, in Remsen township; copper bolt in boulder west side of road in pasture, 55 feet from road center, marked "1262 Ft. R." 1,262.021

Hinckley, 3.4 miles northeast of; nail in root of elm tree beside double maple tree on line of wire fence south side of road, about 290 feet west of Oneida-Herkimer county line 1,248.68

Northwood, chiseled square on stone abutment at northwest corner of iron bridge over stream at saw-mill 1,207.95

Northwood, .6 mile east of; chiseled square on boulder on south side of road opposite road from the north and in front of an old abandoned schoolhouse 1,228.89

Northwood, 2.2 miles east of; chiseled square on boulder north side of road 150 feet east of old abandoned house 1,249.22

Northwood, 2.8 miles east of; copper bolt in large boulder 7 feet north of center of road and 3,450 feet west of abandoned house south of road, marked "1258 Ft R" 1,258.048

Northwood, 3.7 miles east of; chiseled square on large boulder sticking out of bank left side of road going south and fording West Canada creek 1,239.68

Northwood, 4.8 miles east of; chiseled square on large flat boulder 15 feet north of center of road near wire fence 1,264.87

Northwood, 5.2 miles east of; chiseled point, painted black, and marked H''', on a large boulder 125 feet north of road and 100 feet west of small house. This is a State bench-mark 1,289.43

Hubberd's Hotel, .18 mile east of; State bench-mark on boulder in meadow about 60 feet south of road and 25 feet east of a fence; chiseled point, painted and marked "E'''"	1,276.65
Ohio, 3.3 miles north of; chiseled circle on large boulder 5 feet west of center of road	1,307.51
Ohio, 2.4 miles north of; chiseled square on boulder on west side of road in front of a blue house at bend in road to east	1,326.86
Ohio, 1.7 miles north of; nail in root of large maple tree 75 feet east of road near junction with road northwest and southeast	1,396.23
Ohio, 750 feet west of corner near church, 1,200 feet east of schoolhouse and 80 feet north of road, in field belonging to G. Johnson; copper bolt, marked "1374 Ft. R."	1,374.160
Ohio, private burial ground opposite schoolhouse; top of footstone of grave, marked D. B., near Boyce monument	1,377.61
Ohio, 1.1 miles south of; chiseled square on large round boulder west of road 225 feet north of bridge across small stream	1,262.19
Ohio, 2.6 miles southwest of; chiseled square on stone foundation at northeast corner of iron bridge over Black creek	1,236.47
Cold Brook, 3.4 miles north of; and 3.6 miles south of Ohio; copper bolt in boulder 3 feet outside of wire fence on west side of road, 480 feet south of road from west and 1 mile south of crossing of Black creek, in Prussia township; bolt is marked "1265 Ft. R."	1,265.023

Cold Brook, 3.1 miles northeast of; chiseled square in small boulder 2 feet north of fence in field on north side of road about 125 feet west of wood colored house on the north	1,401.92
Cold Brook, 2.4 miles northeast of; chiseled square on small boulder in sand about 6 feet west of west branch of road which follows bottom of ravine	1,271.80
Cold Brook, 1.7 miles northeast of; chiseled square on boulder at southwest corner of red bridge across Cold Brook, near cheese factory	1,057.38
Cold Brook, 1.3 miles northeast of; chiseled circle in boulder 6 inches above ground in front of yellow house on west side of road	1,004.25
Cold Brook, .7 mile northeast of; top of iron ring in stone hitching post, northwest side of road, opposite blacksmith shop	928.70

FROM NEAR WILMURT, VIA NOBLEBORO, TO HONNEDAGA LAKE.

Mad Tom creek, wooden truss bridge over; chiseled square on small boulder 4 feet from northeast corner of bridge	1,297.28
Wilmurt, .7 mile west of and 165 feet east of Henry Paull's hotel; top of bronze tablet in large boulder 70 feet south of center of road, in pasture marked "1,402 Ft. R."	1,401.577
Wilmurt, chiseled square on boulder in angle at three corners opposite postoffice; iron bridge across West Canada creek	1,393.80
Wilmurt, 8 mile northeast of; State benchmark on large boulder in meadow 250 feet south of road; chiseled point, painted black, marked "W."	1,385.35

Wilmurt, 1.9 miles northeast of; nail in blazed root of large maple tree north side of road................	1,437.46
Nobleboro, 225 feet east of hotel; chiseled square on small boulder 4 feet from fence on north side of road.	1,418.99
Nobleboro, .4 mile north of; State benchmark No. 2 on small boulder at top of hill north side of road; chiseled point, painted black....................	1,512.25
Nobleboro, .6 mile north of; State benchmark No. 3 on boulder 6 feet east of road and 40 feet south of small wooden bridge; chiseled point, painted black.	1,521.67
Nobleboro, 1 mile north of; State benchmark No. 4 on boulder beside maple tree south side of road 100 feet west of house on same side of road; chiseled point, painted black	1,543.26
Nobleboro, 1.5 miles north of; State benchmark No. 6 on boulder west of road and 40 feet west of small wooden bridge; chiseled point, painted black......	1,512.70
Nobleboro, 2.4 miles north of; State benchmark No. 9 on large boulder 8 feet south of center of road and 225 feet west of Haskell hotel; chiseled point and painted black	1,574.46
Nobleboro, 2.64 miles north of; State benchmark No. 10 on boulder about 4 feet to right of road, chiseled point and painted black..........................	1,591.68
Nobleboro, 3.06 miles north of; State benchmark No. 11 on large, flat ledge at left of roadway, chiseled point and painted black..........................	1,599.08
Nobleboro, 3.51 miles north of; chiseled circle on large, flat boulder in old gravel pit on right of road; elevation in black paint..............................	1,685.19

Nobleboro, 3.97 miles north of; chiseled point marked with black paint on boulder west of road.......... 1,794.039

Nobleboro, 4.77 miles north of; nail in beech stump, marked with black paint, 2 feet east of wagon track. 1,973.80

Nobleboro, 5.27 miles north of; large granite boulder 10 feet east of center of road and 150 feet east of small stream in deep ravine or gulch; chiseled circle and black paint mark.......................... 1,884.31

Nobleboro, 5.85 miles north of; chiseled square and black paint mark on boulder about 4 feet west of center of road................................ 1,977.47

Nobleboro, 6.57 miles north of; boulder 7 feet east of center of road in upper end of gravel pit, chiseled circle and black paint.......................... 2,236.83

Nobleboro, 7.31 miles north of; chiseled square and black paint mark on large, flat boulder in old gravel pit on west of road, top of hill.................... 2,507.38

Nobleboro, 7.89 miles north of; chiseled circle and black paint mark on boulder 25 feet left of road and about 50 feet north of old gravel pit partly filled with water 2,493.60

Honnedaga lake, 2.68 miles south of; chiseled square and black paint mark on boulder 9 feet east of center of road 2,524.19

Honnedaga lake, 2.12 miles south of; chiseled square and black paint mark 6 feet west of center of road and 500 feet south of long bridge................ 2,290.82

Honnedaga lake, 1.58 miles south of; chiseled square and black paint mark on small round boulder 20 feet east of road.................................. 2,254.67

Honnedaga lake, 1.35 miles south of; chiseled square and black paint mark on large boulder 10 feet east of road 2,243.07

Honnedaga lake, 1.04 miles south of; chiseled square and red kiel mark on large boulder 5 feet east of center of road.. 2,205.79

Honnedaga lake, Herkimer landing; copper bolt in very large boulder about 35 feet southwesterly from corner of barn and about 325 feet from lake, marked "2,223 Ft. R."................................ 2,222.717

NOBLEBORO TO MOREHOUSEVILLE.

Nobleboro, .7 mile east of; chiseled square on large boulder 8 feet south of center of road............. 1,522.35

Nobleboro, 1.5 mile east of; State benchmark on boulder 15 feet north of road near small maple tree and about 150 feet east of road coming in from south; marked with black paint and "P"................ 1,601.63

Nobleboro, 2.5 miles east of; chiseled square on large boulder 7 feet south of center of road and 400 feet west of house on south side of road............... 1,637 40

Nobleboro, 3.3 miles east of; chiseled square on boulder 15 feet south of road, ¼ mile east of cheese factory.. 1,690.14

Nobleboro, 3.9 miles south of; chiseled circle on boulder on lowest side of road 25 feet east of road coming in from southwest.......................... 1,775.15

Nobleboro, 4.4 miles east of; chiseled square on boulder 15 feet left of road.......................... 1,808.72

Morehouseville, copper bolt in flat ledge 15 feet south of center of road to Piseco Lake, 425 feet east of schoolhouse, and 940 feet east of road south at postoffice, marked "1911 Ft. B. M."................. 1,910.429

Prospect, along Adirondack and St. Lawrence Railroad, via Forestport and McKeever to Old Forge.

Prospect, 1,150 feet north of postoffice; copper bolt, in large boulder in field opposite creamery, and marked "U. S. G. S. 1142 Ft. B. M."	1,141.520
Prospect, 1,000 feet northeast of depot on Hinckley branch railway; northwest corner of coping of parapet north side of culvert, marked "O BM 55" with chisel	1,147.25
Remsen, north end of retaining wall between lower mill dam and Rome, Watertown and Ogdensburg railroad; crossmark on bronze tablet set in end of coping near face corner, marked "11722"	1,171.873
Remsen, 1 mile north of at A. & St. L. Ry. bridge; chiseled square on south abutment, west end parapet	1,204.37
Remsen, 2½ miles north of, boulder 20 feet east of track, 10 feet north of farm road crossing and 750 feet south of public road crossing, marked with chisel square	1,218.55
Honnedaga station, ¼ mile north of, 40 feet west of track opposite cattle guard; copper bolt, in boulder 15 feet wide and 6 feet high, marked "U. S. G. S. R 1209 Ft. R B. M."	1,208.733
Honnedaga station, ¼ mile north of; top step, northwest wing of cattle guard, chiseled square	1,212.69
Forestport station, 2 miles south of; north end of Black River (reservoir) bridge, chiseled square on west end of coping of parapet	1,179.29

Forestport station, 100 feet west of on road to village and 30 feet south of road; black cherry tree, 2 feet in diameter; nail in notched root west side tree...	1,199.25
Forestport station, .3 mile north of; north end of railroad bridge over Little Woodhull creek, west end of parapet coping, copper bolt marked "U. S. G. S. R 1199 Ft. B. M."	1,199.378
Forestport, 2¼ miles north of at Anos siding; notch on root of poplar tree 6 inches in diameter 50 feet east of track	1,300.07
Forestport, 2¾ miles north of; cattle pass ½ mile north of road crossing; chiseled square on top step, north-east corner	1,302.47
White Lake station, 2 miles south of; near Nichols Mills; chiseled square on face of coping at north-west corner Bear Creek railway bridge	1,370.43
White Lake station, 50 feet west of railroad track, 10 feet north of wagon road; copper bolt, in boulder 6 feet broad, marked "U. S. G. S. R 1421 Ft. B. M."	1,421.037
White Lake station, 2½ miles north of and 100 feet north of White Lake Granite Company's switch; west of track at foot of embankment, iron staple set in boulder 20 feet broad	1,457.19
White Lake Granite Company's switch, 1 mile north of; chiseled square on north end of east parapet of culvert	1,531.00
Otter Lake, 15 feet north of walk, west of railroad track and midway between it and hotel; square chisel mark on boulder 8 feet wide	1,549.71

McKeever, 600 feet south of station, west of railroad track, in rock in cut; copper bolt, marked "U. S. G. S. R 1544 Ft. B. M."	1,544.232
McKeever, 2 miles north of; iron railway bridge No. 6 (20-foot span); chiseled square near face corner end of coping, northwest wing	1,559.53
McKeever, 2½ miles north of, at Nelson Lake dam; chiseled square in boulder 6 feet east of track, 150 feet south of house	1,616.41
McKeever, 3½ miles north of at railroad bridge No. 37 (90-foot span) over Moose river; chiseled square on face angle, north abutment, west end, one foot from girder	1,641.76
Minnehaha station, Moose river bridge; chiseled square on face corner, east end of parapet, north end	1,681.82
Fulton Chain station, 3 miles south of, 500 feet north of house; chiseled square on north end of parapet, south end of culvert	1,714.71
Fulton Chain, ¾ mile south of; opposite lock, railroad spike in side of first telegraph pole south of trail to lock	1,697.26
Fulton Chain, 5 feet north of Wakeley's Hotel, 8 feet east of railroad track; crossmark on bronze tablet, set in boulder, marked "R 1712"	1,712.308
Old Forge, ¼ mile west of railroad station, at picnic ground; boulder 12 feet square and 7 feet high, 15 feet north of railroad track; crossmark in bronze tablet, marked "R 1733"	1,732.979

OLD FORGE, ALONG NORTH SIDE FULTON CHAIN LAKES TO EAGLE BAY OF FOURTH LAKE.

Old Forge, 2½ miles northeast of, at summit; horseshoe nail in hemlock stump, north edge of road.........	2,004.97
Old Forge, 3½ miles northeast of, at outlet of Bald Mountain pond; chiseled square on boulder 6 feet wide and 3 feet high at northwest corner of Corduroy bridge..	1,962.84
Bald Mountain, west side of trail to, from Bald Mountain House, where trail crosses road from Old Forge to Eagle Bay of Fourth Lake; root of birch stump, south side of road, west side of trail...............	1,829.69
Third Lake, Fulton Chain, at Bald Mountain House; bronze cap on iron benchmark post, 40 feet east of dock, 8 feet from north shore of lake; marked "R 1712".......................................	1,7115.94
Bald Mountain trail, 3 miles east of, opposite road to Lawrence Camp; chiseled square on boulder 8 feet wide, 10 feet south of road.......................	1,744.94
Eagle Bay, 40 feet west of road to dock, 50 feet from shore of lake; chiseled square on outcrop in front of hotel...	1,721.12

FOURTH LAKE, VIA SIXTH LAKE DAM TO FAWN LAKE.

Fourth Lake, Fulton Chain, at Hess Inn. Iron benchmark post set in ground on north bank of Fifth Lake outlet 40 feet north of boathouse and billiard-room, 70 feet south of main hotel building, 175 feet east of sea wall on lake front of lawn, 3 feet northeast of sidewalk crossing; bronze cap marked "R 1717"...	1,716.928

Sixth Lake, Fulton Chain, 125 feet east of north end of dam; boulder 10 feet broad, 4 feet high, 4 feet from edge of dock; bronze tablet, marked "R 1788".....	1,787.938
Sixth Lake dam, 1.6 miles south of; summit, Seventh Lake Mountain; boulder 5 feet broad, 8 feet west of road; chiseled square............................	2,134.61
Fawn Lake, 500 feet east of, at bridge over inlet; notched root of birch tree 10 inches in diameter 10 feet east of bridge on north bank of creek..........	1,950.77
Fawn Lake, 1½ miles south of, on road from Sixth Lake to Kenwells; 900 feet south of summit, 25 feet north of small brook; boulder 12 feet square, 8 feet high, 10 feet east of road at south end of level stretch of road; crossmark on bronze tablet, marked "R 2263".....	2,262.617

Queens County.

HEMPSTEAD AND OYSTER BAY QUADRANGLES.

The elevations published in the following list are based on the marking "+18.0555" made with a chisel on the face of the retaining wall of Long Dock, in the Military Post grounds at Willett's Point. The elevation of this benchmark was accepted as 14.060 feet above mean sea level as obtained from tidal gauge observations made by the U. S. Coast and Geodetic Survey, and the Corps of Engineers, U. S. Army, at Willett's Point. The leveling was done under the general direction of Mr. E. B. Clark, topographer, by Mr. Clark Brown, levelman.

WILLETTS POINT VIA BAYSIDE AND QUEENS TO MINEOLA.

Willetts Point, military post grounds; long dock, face of retaining wall under coal shed, marked "+ 18.05555" with chisel........................	14.060

Bayside, northeast corner Bell and Park avenues, 150 feet south of railroad crossing; top of fire hydrant.	76.66
Queens, ¾ mile north of, opposite site of new schoolhouse, east of road; 6-inch cherry tree, notch in trunk	82.1
Creedmoor schoolhouse, northwest corner of Madison avenue and Pine street; iron benchmark post set in ground 15 feet from south line of lot and 2 feet from front line, bronze cap, marked "85 W. P."	85.163
Floral Park, ¼ mile northwest of; chiseled square on bridge seat at west end of overhead railway crossing	96.91
Mineola, 1 mile west of; 100 feet east of crossroads; notch on root of 2-inch cherry tree south of road by fence	97.2

MINEOLA VIA JERICHO TO EAST NORWICH.

Mineola, ½ mile north of; wire nail in stump of telegraph pole at northeast corner of railroad crossing	109.81
Mineola, 2½ miles northeast of and 2 miles east of railroad crossing, on the Queens-Jericho turnpike, 200 feet east of road to south; nail in root of 15-inch maple tree, south side of road	122.58
Jericho, 2 miles west of, ¼ mile east of cross roads, 15 feet north of road; top of bell of iron pipe culvert..	135.02
Jericho, top of marble highway monument in triangle of roads opposite hotel	194.08
Jericho, Jericho turnpike at fork of roads to Oyster bay and Syosset; retaining wall east of road, 15 feet from driveway to residence; cross mark on bronze tablet marked "218 W. P."	218.160

East Norwich, 1-3 mile south of; wire nail in top of stump of locust tree 12 inches in diameter 4 feet from fence corner southeast corner of crossroads..	215.60
East Norwich, 300 feet south of church, notch in root of black walnut tree 3 feet in diameter opposite small cemetery	186.4

East Norwich via Roslyn to Bayside.

Brookville, doube pipe culvert at crossroads; top of bell of north pipe at southeast corner of roads	122.75
Glen Head, 1,000 feet east of road to; top of bell south end of iron pipe drain	140.35
Wheatly Hills railroad station, 1,000 feet south of; 300 feet east of railroad crossing; notch on west side of apple tree by south road fence	204.5
Roslyn, north entrance to new school grounds; center of first step above bottom landing	37.04
Roslyn, west side of south front of upper basin on public fountain; crossmark on bronze tablet, marked "37 W. P."	37.452
Roslyn, southeast corner of Main street and turnpike; south end of lower step, entrance to granite clock tower	40.08
Roslyn, 7-8 mile west of; top of large boulder 100 feet east of cross roads and 50 feet east of hotel	166.44
Roslyn, 1½ miles west of; notch on root of double trunked oak tree 12 inches in diameter at southwest corner of cross roads	175.7
Manhassett, notch on root of maple tree 18 inches in diameter, east side of hill road 100 feet south of folk road west of pond..........	51.3

Little Neck, notch on root of cherry tree 2 inches in diameter at northwest corner of roads............	93.2

MINEOLA VIA GARDEN CITY AND HEMSTEAD TO MERRICK.

Mineola, north corner west face of pier north of door in foundation west side railroad water tank	105.52
Mineola, crossmark, on bronze tablet, set in coping west end of north pier of railroad water tank; tablet is marked "105 W. P."..........................	105.291
Garden City, First street south of railroad; top of valve stem, fire hydrant northwest corner of street..	87.17
Hempstead, south side of Front street 25 feet west of Main street; top of fire hydrant	54.06
Merrick, 100 feet north of railroad crossing; point in center of stone monument, 6 inches square, on east line of street	18.73
Merrick, southwest corner of railroad crossing about 15 feet from center of track, 5 feet west of west line of street, 15 feet north of corner of store; iron bench-mark post, bronze cap, marked "19 W. P."........	18.834

MERRICK VIA FREEPORT AND ROCKVILLE CENTER TO MINEOLA.

Freeport, northeast corner Main and Fulton streets; top of fire hydrant	23.01
Milburne, Brooklyn Water Works Reservoir, overflow structure; southeast corner of coping of pier......	11.41
Rockville Center, 300 feet south of railroad crossing; southeast corner of Village avenue and Observer street; top of fire hydrant	27.66

Rockville Center, northeast corner of Village avenue and Observer street; crossmark on bronze tablet set in stone water table of brick building, north of door, between pilaster and window, marked "26 W. P."..	26.378
Rockville, 1¼ miles north of; large reservoir, corner of stone on tangent, north face coping of north extension of slope wall, east side of reservoir........	36.48

During the past fiscal year plans, estimates and specifications have been prepared for 87 separate contracts (aside from those connected with the $9,000,000 canal improvement), which were awarded during the year and which are estimated to cost $347,725.76.

An enormous number of plans, etc., for work not yet undertaken have also been made, and our forces have been called upon to guide and direct numerous pieces of repair work for which no plans were required.

In addition to the laws relating to the expenditure of the $9,000,000 for improving the Erie, Oswego and Champlain canals, and the so-called "Ordinary Repairs" bill, and a similar one (Chapter 566 Laws of 1897), providing $360,000 for miscellaneous improvements on the various canals, 150 other or special laws carrying appropriations amounting to $1,458,296.44 have required attention during the year.

Final accounts have been rendered for 57 separate pieces of work, involving a total cost of $780,657.25.

CONCLUSION.

In connection with the work of the various boards and commissions, of which the State Engineer is a member, by virtue of his office, I believe that the foregoing report indicates that this is the

busiest year that has ever been experienced by this department, and it would be unjust and ungrateful of me to close this report without a word of appreciation and thanks to those of my assistants who have helped to accomplish so much during the year. The various pieces of work that have been under way during the past year, and the expenditures connected therewith are described in the reports of the Division engineers, which are hereto annexed.

All of which is respectfully submitted.

CAMPBELL W. ADAMS,

State Engineer and Surveyor.

Engineering Expenses for the Fiscal Year.

ORDINARY REPAIR FUND.

Canals.

DIVISIONS.	Erie.	Champlain.	Oswego.	Black River	Cayuga and Seneca
Eastern	$7,538 24	$3,744 26	....	....	....
Middle.	5,006 35	....	$874 12	$1,482 25	$320 19
Western.	10,035 24	....	....	....	....
Total	$22,579 83	$3,744 26	$874 12	$1,482 25	$320 19

Total for Ordinary Repairs, $29,000 65.

Special Appropriations.

Examination, monuments and maps, disbursed by divisions engineers, chapter 950, Laws of 1896 and chapter 790, Laws of 1897	$4,844 70
Examination, monuments and maps, paid directly by State Treasurer, chapter 950, Laws of 1896 and chapter 790, Laws of 1897	7,473 98
Making surveys and maps for use of the State Board of claims, chapter 950, Laws of 1896 and chapter 790, Laws of 1897	12,964 90
Upper Hudson River Survey, chapter 320, Laws of 1896	1,880 09
Topographical Survey, New York State, chapter 480, Laws 1896, chapter 391, Laws of 1897	14,000 73
	$41,164 40

SUMMARY.

Ordinary repairs	$29,000 65
Extraordinary canal improvement	331,319 19
Special appropriations	41,164 40
Total engineering expenses	$401,484 24

EXTRAORDINARY CANAL IMPROVEMENT.

Eastern Division.

Repairs Schenectady wall, chapter 288, Laws of 1895	$131 90
Sidewalks Schenectady Bridge, chapter 492, Laws of 1895	130 00
Approaches, etc., Maple street bridge, Sandy Hill, chapter 286, Laws of 1895, chapter 975, Laws of 1896	92 67
Culvert over weigh lock outlet, Waterford, chapter 364 Laws of 1896	416 45
Bridge over Glens Falls feeder, Glen street, Glens Falls, chapter 798, Laws of 1896	264 75
Repairs to Rexford's Flats dam, chapter 560, Laws of 1895, chapter 947, Laws of 1896, chapter 566-572, Laws of 1897	328 90
Bullard's bridge, Champlain canal, chapter 254, Laws of 1896	142 73
Deepening and widening between Great South Bay and Shinnecock Bay, chapter 348, Laws of 1896, chapter 790, Laws of 1897	837 35
Shinnecock and Peconic canal, piling and protecting, chapter 950, Laws of 1896, chapter 791, Laws of 1897	87 54
Lengthening locks 21 and 22 Erie canal, chapters 79 and 320, Laws of 1895, chapter 794, Laws of 1896.	6,287 64
Extraordinary repairs Erie and Champlain canals, chapter 947, Laws of 1896, chapter 566, Laws of 1897	9,280 09
Improvement Erie Canal, chapter 79, Laws of 1895, chapter 794, Laws of 1896, chapters 43 and 569, Laws of 1897	57,692 26

Improvement Champlain canal, chapter 79, Laws of 1895, chapter 794, Laws of 1896, chapters 43 and 569, Laws of 1897	$30,602 11
River street lift bridge, Fort Plain, chapter 576, Laws of 1897	211 68
Fourth street bridge, Waterford, chapter 575, Laws of 1897	46 50
Railroad street lift bridge, Ilion, chapter 105, Laws of 1897	597 83
	$107,150 40

EXTRAORDINARY CANAL IMPROVEMENT.

Middle Division.

Genesee street bridge at Utica, chapter 560, Laws of 1893, chapter 170, Laws of 1895	$2,083 47
Repairs to Owasco Lake outlet, chapter 99, Laws of 1895, chapter 799, Laws of 1896 and chapter 561 Laws of 1897	1,654 06
West Genesee street bridge, Syracuse, chapter 311, Laws of 1895	1,233 53
Canasaraga Creek culvert, chapter 969, Laws of 1895	86 19
Thomas street bridge, Rome, chapter 970, Laws of 1895	130 00
Extraordinary repairs, middle division, chapter 566, Laws of 1897	1,877 46
Otisco Lake inlet bridge, chapter 497, Laws of 1895, chapter 793, Laws of 1896	450 50
Improving Oswego canal, chapter 219, Laws of 1895,	65 10
Bridge over Oswego canal at Fulton, chapter 113 Laws of 1897	300 00

Protecting Cayuga and Seneca canal at Geneva, chapter 142, Laws of 1895	$347 54
Improving Cayuga and Seneca canal and Seneca lake outlet, chapter 308, Laws of 1895	173 58
Improving Cayuga and Seneca canal at Waterloo, chapter 512, Laws of 1895	165 00
Improving Cayuga and Seneca canal at Seneca Falls, chapter 512, Laws of 1895	30 17
Cleaning ditch between Waterloo and Seneca Falls, chapter 932, Laws of 1895, chapter 950, Laws of 1896	267 98
Repairs to North Branch Reservoir, chapter 148, Laws of 1895	405 97
River bridge at Carthage, chapter 102, Laws of 1895,	670 17
Rebuilding lock No. 96, Black River Canal, chapter 947, Laws of 1896	1,520 79
Rebuilding Lock No. 49, Black River Canal, chapter 947, Laws of 1896	1,810 69
Extraordinary repairs middle division Black River Canal, chapter 566, Laws of 1897	2,174 49
Surveys on account of Attorney-General, chapter 932, Laws of 1895	42 42
Improvement of the Erie canal, chapter 79, Laws of 1895, chapter 43, Laws of 1897	84,931 59
Improvement of the Oswego canal, chapter 79, Laws of 1895, chapter 43, Laws of 1897	18,623 44
Highway, Onondaga Indian Reservation, chapter 932, Laws of 1895	11 57
Extraordinary repairs middle division, chapter 947, Laws of 1896	4,260 51
Filling pond at Oneida Castle, chapter 515, Laws of 1897	17 82

Improving Butternut Creek, chapter 1009, Laws of 1895	$9 57
	$131,026 52

EXTRAORDINARY CANAL IMPROVEMENT.

Western Division.

Porter avenue bridge, Buffalo, chapter 590, Laws of 1895	$2,224 23
Dredging Lower Black Rock harbor, chapter 320, Laws of 1895	308 57
Rebuilding vertical wall at Sodus street, Clyde, chapter 947, Laws of 1896	61 95
Rebuilding vertical wall at Montezuma street, Lyons, chapter 947, Laws of 1896	139 53
Enlarging spillway, Cuba reservoir, chapter 950, Laws of 1896	200 00
Rebuilding vertical wall between South Clinton and South St. Paul streets, Rochester, chapter 947, Laws of 1896	383 50
Improving channel of Falls creek, Montour Falls, chapter 797, Laws of 1896	500 00
Dyke along Chemung river, at Chemung, chapter 949, Laws of 1896	500 00
Dredging and removing obstructions, Findley's lake, chapter 950, Laws of 1896, and chapter 790, Laws of 1897	126 94
Repairing highways, Cattaraugus Indian Reservation, chapter 949, Laws of 1896	32 33
Completing bridge across Cattaraugus creek, chapter 950, Laws of 1896	150 00
Repairs to dock in Erie basin, chapter 489, Laws of 1896	100 00

Buoys in Erie basin, chapter 521, Laws of 1896....	$23 00
Improving channel of Newtown creek, chapter 949, Laws of 1896, and chapter 791, Laws of 1897.....	2,467 72
Exchange street bridge, Rochester, chapter 514, Laws of 1896, and chapters 572 and 791, Laws of 1897	75 00
Bridge over Oak Orchard feeder, Medina, chapter 791, Laws of 1896, and chapter 790 Laws of 1897.	71 55
Rebuilding Newark waste-weirs, chapter 947, Laws of 1896	390 00
Replacing two 24-inch pipes with one 48-inch pipe under Erie canal between Ninth and Tenth streets, Rochester, chapter 947, Laws of 1896...........	333 00
Dyke along the Chemung river, Elmira, chapter 950, Laws of 1896, and chapter 790, Laws of 1897.....	1,088 89
Building bridge and improving State roads, Tonawanda Indian Reservation, chapter 950, Laws of 1896, and chapter 790, Laws of 1897.............	200 00
Improving channel leading from State culvert under Erie canal at Brockport, chapter 947, Laws of 1896	165 48
Deepening and improving Cayuga creek, chapter 559, Laws of 1897..........	193 21
Deepening and improving Mud creek, chapter 447, Laws of 1896..........	340 60
Repairing and preserving highways on the Cattaraugus Indian Reservation, chapter 790, Laws of 1897	54 48
Constructing a bridge over the Allegany river between Carrollton and Allegany, chapter 790, Laws of 1897	182 40
Genesee River storage dam, chapter 950, Laws of 1896	2,598 29

Repairing abutments of Cook's bridge and lengthening culverts 33 and 34, and rebuilding culverts 32, all in Pittsford, chapter 947, Laws of 1896.......	$258 66
Building temporary aqueduct and coffer-dam at Lockport, chapter 947, Laws of 1896............	120 00
Rebuilding iron culvert under Genesee River feeder at Rochester, chapter 947, Laws of 1896.........	227 50
Rebuilding and repairing culverts 36 and 38 at Brighton, chapter 947, Laws of 1896............	482 70
Rebuilding culvert between Medina and Knowlesville, chapter 947, Laws of 1896................	502 00
Repairing waste-weirs at Lockport, Middleport and near Mabee's bridge, chapter 947, Laws of 1896...	185 20
Removing old pile dam across Chemung river at Corning, chapter 790, Laws of 1897.............	88 83
Repairing and preserving highways on the Allegany Indian Reservation, chapter 790, Laws of 1897...	119 89
Special surveys, Court of Claims, chapter 950, Laws of 1896	335 61
Rebuilding Brighton's waste-weir and north head wall of Allen's creek culvert, chapter 947, Laws of 1896	306 60
Rebuilding berme abutment of Jay street bridge at Rochester, chapter 947, Laws of 1896...........	288 00
Rebuilding culverts Nos. 1 and 2, chapter 947, Laws of 1896	580 91
Canal improvement, chapter 794, Laws of 1896, and chapters 43 and 569, Laws of 1897.............	93,142 27
	$109,548 84

Final accounts passed in this office during the fiscal year ending September 30, 1897.

Number.	CHARACTER OF WORK.	Name of contractor.	Engineer's estimate at contract prices.	Amount of final account.
1	A steel bridge over the Erie canal at the junction of the Erie and Champlain canals and preparing old abuts to receive same....	Hilton Bridge Construction Co...	$6,754 75	$7,378 90
2	Lengthening locks 21 and 22, Erie canal, and for other works, etc.	Chambers & Casey...............	96,303 90	118,239 73
3	For the improvement of the eastern division of the Erie canal from lock 44 to lock 45, a distance of 1.24 miles................	John V. Quackenbush	38,749 30	45,315 35
4	For the improvement of the eastern division of the Erie canal from lock 42 to lock 44, a distance of 2.96 miles	John V. Quackenbush	113,436 66	141,591 14
5	Extending wall at guard lock, rebuilding the berme and raising the towing path abutment of the Maple street bridge, and for rebuilding the superstructure and raising the approaches, etc..	Jeremiah Adams.................	7,343 60 1,130 12	9,026 70
6	Repairing steel dam across Mohawk river at Cohoes............	Cunningham & Monty	11,710 00	11,609 09
7	A stone arch culvert over the weigh lock outlet at Second street and for outlet walls between Second street and the Hudson river, on the Champlain canal, at Waterford..................	Michael Bennett................	3,641 75	3,365 98
8	An iron bridge on the Champlain canal at the Bullard farm, Northumberland, Saratoga county, N. Y......................	Cunnit y	3,400 70	4,017 55
9	A bridge over Glens Falls feeder at Glen street, Glens Falls.....	Hilton uction Co...	4,057 50	4,302 28
10	Rebuilding lock 9 (Becker's), Champlain canal	John J	27,447 00	25,453 31
11	To rebuild waste wier over Glens Falls feeder near the Glens Falls Co.'s lime kiln..	Jeremiah Adams.................	2,830 70	3,073 00
12	A steel bridge superstructure (Wilson's road bridge), Champlain canal	Hilton Bridge Construction Co...	660 00	660 00
13	An iron bridge superstructure between locks 15 and 16 Champlain canal..	Hilton Bridge Construction Co...	630 00	630 00
14	For the improvement of the Champlain canal from a point about 200 feet south of Waterford side cut to lock No. 5, a distance of 1.3 miles	Whalen & Higgins	58,376 00	89,940 41
15	For the improvement of the Champlain canal from lock No. 6 to lock No. 7, a distance of 3.0 miles...........................	John W. Whalen.................	92,296 00	116,634 00

16	For a concrete coping on sea wall between East Marion and Orient	James J. Dwyer	1,700 00	2,051 00
17	For piling and protecting the banks of the Shinnecock and Peconic canal	P. J. Brummelkamp	10,671 50 4,000 00	13,348 04
18	Iron bridge superstructure over Black River at Carthage	Buffalo Bridge and Iron Works	18,921 69	15,170 00
19	Alterations and repairs to piers and abutments to Carthage bridge	Dunfee, Belden, Dwyer & Co	5,135 00	5,403 15
20	Improving Cayuga and Seneca canal and the outlet of Seneca lake	E. H. Flemming & Co	13,600 00	10,927 72
21	Discharge pipes for north branch reservoir	John H. Nelson	17,983 00	17,316 05
22	Continuing construction of bridge and approaches over inlet to Otisco lake	Hughes Bros	8,912 00	9,782 81
23	Repairing culvert under Oswego canal between the hydraulic canal and old Shenandoah mills	Edward S. Candee	3,896 00	8,654 75
24	Superstructure lift bridge at West Genesee street, Syracuse, N. Y.	Hilton Bridge Construction Co	....	10,221 40
25	Substructure lift bridge at West Genesee street, Syracuse, N. Y.	*Brummelkamp & Lane	14,923 25	10,129 39
26	Steel trunk for Saquoit creek aqueduct	Hilton Bridge Construction Co	7,080 00	8,227 57
27	Rebuilding culvert No. 80, Erie canal	Daniel Baldwin	2,098 00	2,437 82
28	Improving channel of Bloody brook, etc., etc	E. B. Baker	13,855 25	14,381 74
29	A steel swing bridge near Lowville, known as Illingworth bridge	The Owego Bridge Co	2,727 50	3,002 78
30	Rebuilding lock No. 96 on the Black River canal	Dodge & McGregor	14,233 50	19,521 93
31	Rebuilding lock No. 49 on the Black River canal	William J. Crammond	16,744 00	16,899 19
32	Rebuilding bridge over Black river at Glendale	Hilton Bridge Construction Co	6,001 50	6,857 35
33	Contract No. 14, Erie canal	John Kelly & Co	15,357 00	17,867 05
34	Contract No. 12, Erie canal	T. J. Dwyer & Co	16,195 50	18,751 15
35	Contract No. 16, Oswego canal	Edwin Lodder	73,925 00	100,075 15
36	Contract No. 11, Oswego canal	Randerson & Seward	30,345 45	32,182 28
37	Moving Porter avenue bridge to Jersey street, Buffalo, N. Y.	Logie & Leh	946 25	2,658 25
38	Substructure Porter avenue bridge, Buffalo, N. Y	Buffalo Dredging Co	19,497 75	23,132 14
39	Superstructure Porter avenue Bridge, Buffalo, N. Y	Buffalo Bridge and Iron Works	51,500 00	51,500 00
40	Bridge and abutments at Schuyler street, Havana, N. Y	White & Coughlin	3,972 00	4,306 25
41	Buoys for Erie basin, Buffalo, N. Y	Connelly Bros	232 50	232 50
42	Dyke along Chemung river at Chemung, N. Y	R. E. Beardsley	3,177 00	4,223 30
43	Dyke along Chemung river at Elmira, N. Y	Pulford, Clark & Tidd	6,397 00	8,762 78
44	Improvement of walls along Falls creek, Havana, N. Y	R. E. Beardsley	3,039 48	4,281 80
45	Abutment for Scott street bridge, Buffalo, N. Y	Dodge & McGregor	3,293 90	3,208 74
46	Repairs to Medina road culvert	Charles A. Gorman	4,723 50	7,252 40
47	Repairs to Cook's bridge and culverts Nos. 32, 33 and 34	B. P. Smith	2,595 75	3,800 84

*City of Syracuse appropriated $10,000 of this sum.

Final accounts passed in this office during the fiscal year ending September 30, 1897—(Concluded).

Number.	CHARACTER OF WORK.	Name of contractor.	Engineer's estimate at contract prices.	Amount of final account.
48	Repairs to Brighton waste wiers and culvert No. 35	B. P. Smith	$3,103 75	$3,021 20
49	Rebuilding Genesee river feeder culvert	B. P. Smith	2,087 50	1,931 03
50	Rebuilding culverts Nos. 36 and 38	B. P. Smith	4,919 70	6,155 88
51	Abutment for Jay street bridge, Rochester, N. Y	John Calnan	2,637 25	3,236 33
52	Pipe culvert near Ninth street, Rochester, N. Y	Chambers & Casey	2,480 75	2,458 56
53	Rebuilding Newark waste wier	Thomas H. Karr	4,010 00	4,700 21
54	Vertical wall near South St. Paul street, Rochester, N. Y	E. L. Oliver	3,880 00	4,729 14
55	Vertical wall near Sodus street, Clyde, N. Y	Chas. A. Lux	1,020 40	1,078 95
56	Vertical wall near Montezuma street, Lyons	Chas. A. Lux	1,414 70	1,453 72
57	Contract No. 4 (Cartersville waste wier)	Whitmore, Rauber & Vicinus	8,485 00	11,097 47

Table of Contracts Pending on the New York State Canals on the 30th day of September, 1897.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative. Chapter.	Legislative. Year.	Appropriation.	Engineer's estimate.	Engineer's estimate at contract prices.	Payment to date.
John W. Whalen	Nov. 10, 1896	For the improvement of the Eastern Division of the Erie canal from Lock 30 to Lock 31, a distance of 3.22 miles	79 794 43 and 569	1895 1896 1897	$9,000,000 00	$57,638 00	$52,910 50	$19,360 00
Lauer & Hagaman	Nov. 17, 1896	For the improvement of the Eastern Division of the Erie canal from Lock 27 to Lock 28, a distance of 5.21 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	75,028 00	74,159 35	73,064 00
Gallo & McNeece	Nov. 9, 1896	For the improvement of the Eastern Division of the Erie canal from Lock 28 to Lock 29, a distance of 1.97 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	33,261 00	31,590 06	26,353 00
Brummelkamp, Lane & Co	Nov. 16, 1896	For the improvement of the Eastern Division of the Erie canal from Lock 32 to Lock 33, a distance of 5.11 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	90,359 66	86,484 38	72,549 00
Lauer & Hagaman	Nov. 17, 1896	For the improvement of the Eastern Division of the Erie canal from Lock 33 to Lock 34, a distance of 2.57 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	46,090 00	43,881 25	41,658 00
Shear & Haight	Nov. 11, 1896	For the improvement of the Eastern Division of the Erie canal from Lock 29 to Bridge 55, a distance of 3.29 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	84,740 00	79,320 50	63,846 00
Thomas H. Karr	Sept. 23, 1897	For the improvement of the Eastern Division of the Erie canal from Lock 29 to Lock 30, a distance of 0.67 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	9,677 00	9,122 50	....
John V Quackenbush	Sept. 21, 1897	For the improvement of the Eastern Division o Lock 45 to County, a d	79 794 43 and 569	1895 1896 1897	9,000,000 00	225,335 00	181,996 00	....
Thomas H. Karr	Sept. 23, 1897	For the impi Division of Lock 19 to 2.71 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	71,073 00	65,812 00	....
Troy Public Works Co	Sept. 16, 1897	For the impr Division o Lock 25 to 4.50 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	149,280 00	132,678 00	....

Table of Contracts Pending on the New York State Canals on the 30th day of September, 1897.—(Continued.)

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative. Chapter.	Legislative. Year.	Appropriation.	Engineer's estimates.	Engineer's estimate at contract prices.	Payment to date.
Clinton Beckwith	Sept. 21, 1897	For the improvement of the Eastern Division of the Erie canal from Lock 40 to Lock 41, a distance of 2.64 miles	79 794 43 and 569	1895 1896 1897	$9,000,000 00	$68,208 50	$58,000 00	....
John V. Quackenbush	Sept. 21, 1897	For the improvement of the Eastern Division of the Erie canal, from Lock 41 to Lock 42, a distance of 2.86 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	73,450 50	59,290 50	....
Clinton Beckwith	Sept. 21, 1897	For the improvement of the Eastern Division of the Erie canal, from Lock 39 to Lock 40, a distance of 2.76 miles	79 794 43 and 569	1895 1896 1897	9,000,000 00	94,489 00	69,820 00	....
Whalen & Higgins	Sept. 14, 1897	For rebuilding apron and repairing dam across the Mohawk river at Rexford Flats	560 947 366 573	1895 1896 1897 1897	20,000 00 125,000 00 *13,149 48	30,216 00	25,981 50	$4,394 00
Hilton Bridge Construction Co.	July 26, 1897	For a lift bridge at Railroad street, Ilion, N. Y.	105	1897	18,0000 00	15,839 00	18,678 30	
Mahan & Sundstrom	Nov. 12, 1896	For the improvement of the Cham-	79 794 43 and 569	1895 1896 1897	9,000,000 00	245,168 76	214,317 53	90,986 00
Havana Bridge Works	Sept. 30, 1897	Fo	575	1897	4,000 00	3,431 75	3,506 75	....
William Coats	Aug. 31, 1897	Fo ... St. Lawrence County, N. Y.	158	1896	2,000 00	1,678 00	1,617 50	1,139 00
Oscar F. Hilt	April 29, 1897	For improvement to the Drake drawbridge over Wappinger's creek, near New Hamburg, Dutchess county, N. Y.	949	1896	1,500 00	1,196 00	1,350 00	901 00
P. J. Brummelkamp	Dec. 7, 1896	For the deepening and widening of the canal leading from Shinnecock to Great South bay, town of South- ...k, N. Y.	948	1896	5,000 00	4,220 00	4,220 00	6,766 00
John J. Hallock	Dec. 8, 1896	...lers, dams ...oving bars	799	1896	10,000 00	8,694 00	9,657 00	6,187 00
John J. Hallock	Sept 1, 1897	...ry wall at foot of Owasco lake	799 561	1896 1897	18,000 00	16,509 00	16,492 00	2,550 00

John J. Hallock	Dec. 7, 1896	...nm	950	1896	48,000 00	3,570 00	2,760 00	2,136 00
E. H. Fleming & Co.	Aug. 6, 1896	...nal	142	1896	15,000 00	15,000 00	10,948 00	9,979 00
Havana Bridge Works	July 31 1896	...see	170	1895	†24,000 00			
		...	950	1896	9,000 00	28,637 15	19,187 40	21,964 00
Wilkes D. Dodge	Sept. 1, 1897	...nal	566	1897	...	15,785 00	15,107 00	1,207 00
Wilkes D. Dodge	Sept. 1, 1897	...nal	566	1897	...	15,785 00	16,772 00	
Havana Bridge Works	April 21, 1896	...ck ...Y.	965	1896	‡*7,000 00	4,000 00	3,184 00	3,636 00
T. J. Dwyer & Co.	Nov. 19, 1896	...	79 794 43 and 569	1895 1896 1897	9,000,000 00	136,468 00	125,820 00	136,449 00
McDonald & Sayre	Nov. 17, 1896	...	"	"	9,000,000 00	165,078 50	146,949 90	160,063 00
John Dunfee & Co	Nov. 14, 1896	...	"	"	9,000,000 00	127,780 50	136,842 00	138,123 00
John Dunfee & Co	Nov. 14, 1896	...	"	"	9,000,000 00	135,931 50	154,471 00	233,613 00
John Dunfee & Co	Nov. 14, 1896	...	"	"	9,000,000 00	141,444 50	150,614 40	115,677 00
Hughes Bros. & Bangs	Dec 8, 1896	...	"	"	9,000,000 00	16,193 50	15,252 00	14,018 00
Owego Bridge Co.	Dec. 14, 1896	" " 17, " " ...	"	"	9,000,000 00	11,236 00	8,891 00	7,954 00
O'Brien & Hoolihan	March 19, 1897	" " 18, " " ...	"	"	9,000,000 00	96,873 00	91,794 50	96,805 00
O'Brien & Hoolihan	March 19, 1897	" " 19, " " ...	"	"	9,000,000 00	106,322 50	105,053 50	59,067 00
Warren Scharf Asphalt Pavi'g Co.	August 17, 1897	" " 20, " " ...	"	"	9,000,000 00	246,653 00	242,757 55	3,907 00
Warren Scharf Asphalt Pavi'g Co.	August 17, 1897	" " 21, " " ...	"	"	9,000,000 00	216,247 00	212,946 46	...
National Contracting Co.	August 6, 1897	" " 22, " " ...	"	"	9,000,000 00	247,465 00	232,307 50	...
E. H. Gaynor	August 23, 1897	" " 23, " " ...	"	"	9,000,000 00	165,897 00	147,568 00	2,106 00
National Contracting Co.	August 6, 1897	" " 24, " " ...	"	"	9,000,000 00	142,061 00	136,720 00	1,279 00
National Contracting Co	August 6, 1897	" " 25, " " ...	"	"	9,000,000 00	140,680 00	127,750 00	1,035 00
John Dunfee & Co	August 5, 1897	" " 26, " " ...	"	"	9,000,000 00	145,452 00	136,400 00	8,780 00
Willoughby B. Priddy	August 18, 1897	" " 27, " " ...	"	"	9,000,000 00	125,969 00	115,718 00	8,576 00
Andrew Onderdonk	August 19, 1897	" " 28, " " ...	"	"	9,000,000 00	172,430 00	167,216 00	10,179 00
Dodge & McGregor	Dec. 8, 1896	" " 6, Oswego canal...	"	"	9,000,000 00	14,497 00	12,206 00	9,756 00
John Kelly & Co	Nov. 16, 1896	" " 7, " " ...	"	"	9,000,000 00	12,616 00	10,696 00	4,518 00
John Kelly & Co.	Nov. 16, 1896	" " 8, " " ...	"	"	9,000,000 00	15,538 00	16,425 50	8,361 00
John Kelly & Co	Nov. 16, 1896	" " 9, " " ...	"	"	9,000,000 00	20,049 00	17,801 00	11,457 00
Hughes Bros. & Bangs	Nov. 20, 1896	" " 10, " " ...	"	"	9,000,000 00	46,058 00	51,570 50	82,346 00
Walter Bradley	Nov. 16, 1896	" " 15, " " ...	"	"	9,000,000 00	66,144 00	62,191 40	18,144 00
Edwin Lodder	Sept. 30, 1897	" " 36, " " ...	"	"	9,000,000 00	61,057 00	48,447 00	...
Willard Johnson	Aug. 30, 1897	" " 37, " " ...	"	"	9,000,000 00	18,586 00	15,382 00	...
Williams, McNaughton & Pabst	Sept. 21, 1896	Building a culvert for Oak Orchard creek, Medina	791 790	1896 1897	5,000 00 2,500 00	6,416 73	6,167 61	...
Frank J. LeValley	August 29, 1896	Improving Mud creek	477	1896	15,000 00	11,620 00	5,810 00	3,655 00
John Dumpy	Sept. 25, 1897	Improving Newtown creek	949 791	1896 1897	6,000 00 7,500 00	6,260 00	6,208 00	...
Charles A. Gorman	Dec. 7, 1896	Rebuilding Lockport, Middleport, Mabee's waste-weirs	947	1897	...	8,444 80	3,631 60	2,465 00
Warwick & Hookway	Feb. 9, 1897	Rebuilding culverts Nos. 1 and 2	947	1897	...	10,666 00	6,791 90	4,946 00
Pulford, Clark & Tidd	October 1, 1897	...mung river	790	1897	4,000 00	3,404 00	3,390 00	...
W. A. Gillette	Sept. 28, 1897	Chemung river at Corning	790	1897	5,000 00	4,090 00	3,100 00	...

* Unexpended balance. † The towns of Lysander and Clay paid $1,500 as their share. ‡ The city of Utica paid $6,000 as their share of Genesee street bridge.

Table of Contracts Pending on the New York State Canals on the 30th, day of September, 1897.—(Concluded.)

NAME OF CONTRACTOR.	Date of contract.	Character of work.	LEGISLATIVE. Chapter.	LEGISLATIVE. Year	Appropriation.	Engineer's estimates.	* Engineer's estimates at contract prices.	Payment to date.
Donnelly Contracting Co.	Nov. 5, 1896	Contract No. 1, Western Division	79-95, 794-96	1895	$9,000,000 00	$433,225,00	$394,955 00	$460,224 00
Buffalo Dredging Co.	Nov. 4, 1896	" " 2, " "	43 and 569-97	1896 1897	9,000,000 00	287,834 00	291,686 25	222,375 00
Charles T. Parker & Co.	Nov. 7, 1896	" " 3, " "	79 794 43 and 569	1895 1896 1897	9,000,000 00	312,510 00	188,541 75	53,766 00
Grannis & O'Connor	Jan. 23, 1897	" " 5, " "	"	"	9,000,000 00	227,102 50	217,119 50	70,758 00
Furnaceville Iron Co	Sept. 23, 1897	" " 6, " "	"	"	9,000,000 00	166,090 00	165,800 00	....
Baker & Banker	Sept. 3, 1897	" " 7, " "	"	"	9,000,000 00	99,725 00	98,760 00	....
William, McNaughton & Bapst	Sept. 2. 1897	" " 8, " "	"	"	9,000,000 00	191,090 00	184,095 00	....
Furnaceville Iron Co	Sept. 23, 1897	" " 9, " "	"	"	9,000,000 00	114,440 00	111,000 00	....
Furnaceville Iron Co	Sept. 23, 1897	" " 10, " "	"	"	9,000,000 00	153,090 00	135,500 00	....
Furnaceville Iron Co	Sept. 23, 1897	" " 11, " "	"	"	9,000,000 00	116,385 00	110,100 00	....
Furnaceville Iron Co	Sept. 23, 1897	" " 12, " "	"	"	9,000,000 00	96,540 00	87,000 00	....
Henry C. Allen & Co.	Sept. 18, 1897	" " 13, " "	"	"	9,000,000 00	119,727 50	105,850 00	....
Whitmore, Rauber & Vicinus	Sept. 20, 1897	" " 14, " "	"	"	9,000,000 00	169,830 00	159,695 00	....
Whitmore, Rauber & Vicinus	Sept 20, 1897	" " 15, " "	"	"	9,000,000 00	90,915 00	88,595 00	....

* The city of Rome paid $3,500 for Garden street bridge; this includes substructure and superstructure. Estimate cost at contract prices is the footing of bidding sheet at the letting.

Eastern Division.

OFFICE OF THE DIVISION ENGINEER,
EASTERN DIVISION N. Y. S. CANALS.

Hon. C. W. ADAMS, *State Engineer and Surveyor:*

Dear Sir.— I have the honor to submit to you my annual report as Division Engineer, Eastern Division, New York State Canals, for the fiscal year ending September 30, 1897.

The Eastern Division is the same as stated in my previous report:

	Miles.
Erie canal from Albany basin to east line of Oneida county	106.243
Port Schuyler and West Troy side-cuts	.350
Albany basin	.770
Champlain canal, including Waterford side-cuts, Cohoes and Saratoga dams	66.000
Pond above Troy dam	3.000
Glens Falls feeder and pond	12.000
Total	188.363

There have been very few interruptions to navigation on this division during the past season. No breaks of importance occurred, though there were several troublesome leaks when the water was first let into the canal last spring, and some of the levels had to be emptied for repairs. This caused two or three days' delay in opening. This was doubtless due indirectly to the

work on the improvement — it has been the custom to leave sufficient water in the canal to cover the bottom of the prism, but during the past winter the canals were thoroughly drained and the frost penetrated to an unusual depth, which heaved the banks and caused them to crack badly, but by energetic work on the part of those in charge of the canal, serious breaks were prevented, though there was considerable leakage during the greater part of the season. The excessive rainfalls during the past summer provided an ample water supply, and there was no difficulty in maintaining the standard depth of water at all times.

The work done on this division during the past year will be referred to further on. The Department was organized as follows:

Dewitt C. Smith, Division Engineer.

Albert J. Himes, Resident Engineer.

T. C. Leutze, First Assistant Engineer (Erie canal).

John R. Kaley, First Assistant Engineer (Champlain canal).

The engineering forces have been engaged in supervising work under contract, completing surveys and detailed plans for deepening the canals, making surveys and maps for the Board of Claims to be used in defense of actions brought against the State for damages, preparing plans for ordinary repairs, when called upon to do so, and in the care of work authorized under special acts of the Legislature.

The names of persons employed, rate of compensation and time of service, will be shown in the tables accompanying this report.

IMPROVEMENT OF CANALS.

Chapter 79, Laws of 1895; Chapter 794, Laws of 1896; Chapters 43 and 569, Laws of 1897.

In October, 1896, the Superintendent of Public Works received bids for twelve contracts on the Eastern Division of the canals.

They were numbered from 1 to 13 inclusive. Contract No. 11, which provided for lengthening locks Nos. 21 and 22, had been previously awarded. All were awarded, except contract No. 1, the bids on which were regarded as excessive. As soon as the contracts were executed, the contractors began making preparations for the work, their progress will be referred to in detail further on. The work is far enough advanced to indicate that the cost will considerably exceed the engineer's estimates. This is due to general increase in quantities and to unforeseen contingencies, which continually arise in work of this character. The work is necessarily performed during the most unfavorable season, the ground being saturated — the alternate freezing and thawing keeps it in the worst possible condition. The material excavated from the prism comes up either in frozen lumps or soft mud and is totally unfit for use in raising the embankment; it has to be wasted, and more suitable material obtained from borrow pits. This increases the quantity of excavation and embankment, as it was expected to use the prism excavation for raising the banks. Some of the walls which were covered with silt were found to be in such a dilapidated condition that they were beyond repair and had to be rebuilt. This is particularly true of the slope walls, which were composed mostly of small field boulders; they had by the action of the elements and settlement of the banks partaken more of the character of riprap than of a pavement, and when the silt, which completely hid them from view, was removed, it was very difficult to draw the line where repairs should cease. The quantity of slope wall will considerably exceed the estimates on nearly all of the contracts. When the silt was removed and the excavation extended down into the natural soil, leaks were developed and they had to be checked, either by sheet

piling, puddling or concrete. Also the amount of seepage from the canal was greatly increased, and tile drains or open ditches had to be provided to carry it away. This has added considerably to the cost of the work. The surface of the towing-path, which was in a very fair condition when the surveys were made, has been badly cut up in consequence of hauling over it the heavy loads of materials used in the work, and will have to be resurfaced, thus increasing the quantity of lining. On some of the contracts hard-pan has been encountered, which under the specifications is classified as rock excavation, which will somewhat increase this item. The plans and estimates, as originally prepared, provided for relaying a much larger portion of the walls covering the entire surface of the towing-path with twelve inches of lining and thoroughly overhauling and repairing the structures, but as the aggregate cost greatly exceeded the amount of funds available, they were reduced with the expectation that the old walls might be saved and the required depth of water obtained at a cost within the limits of the appropriation.

CONTRACT No. 2.—ERIE CANAL.

Dated November 10, 1896, J. W. Whalen, contractor.

Engineer's estimate	$57,688 00	
Additional work authorized by canal board..........................	5,368 00	
		$63,056 00
Estimate at contract prices.......................		52,910 50
Work done, including 10 per cent retained........		21,400 00

This contract extends from lock No. 20 to lock No. 21, a distance of 3.22 miles. The plans provide for lowering the canal bottom two feet. This being a feeder level, that is, it receives the water from the Rexford Flats feeder, it was decided to im-

prove by lowering two feet, instead of raising the water surface to avoid the necessity of raising the dam, which would involve the State in numerous claims for damages on account of overflow back water, etc. This plan was adopted on all the feeder levels on this division.

About one-third of the work on this contract is completed. The progress was rather slow owing to difficulty in procuring materials, there being no suitable stone in the vicinity of the work, and as the work was situated so far from any point that could be reached by railroad, it made the delivery very slow and expensive. The materials are now being delivered by boats and will all be on the ground before the close of navigation.

This contract can easily be completed during the coming winter.

An additional sum of $5,268 was authorized by the canal board for rebuilding the waste-weir near lock No. 20. This was not included in the original contract, but it is very essential that it should be built to guard against overflow to the banks, which is liable to occur during any sudden rise in the river. There will also be some increase in the quantity of lining as the towing-path will have to be resurfaced. The other quantities will remain about the same as estimated.

CONTRACT No. 3.—ERIE CANAL.

Dated November 17, 1896, Lauer & Hagaman, contractors.

Engineer's estimate	$75,028 00	
Additional work authorized by canal board	3,893 20	
		$78,921 20
Estimate at contract prices		74,159 35
Work done, including 10 per cent. retained		86,760 00

This contract comprises the level between lock No. 27 and lock No. 28, a distance of 5.21 miles. The plans provide for lowering the canal bottom two feet.

The contractors made very fair progress. Their efforts during the winter were particularly directed in building the wall and doing necessary excavation for same, intending to do the major portion of the excavation by dredging during the summer. The walls are nearly completed, and they expect to finish the excavation before the close of navigation this season, excepting about one-half mile of prism below the city of Amsterdam, where hard-pan was encountered which could not be excavated by the dredge. There ought to be no difficulty in completing this contract before the close of navigation next season.

The cost of this work will materially exceed the engineers estimate owing to the hard-pan mentioned above, and to the increase in the quantity of vertical and slope wall. The quantity of lining will be somewhat increased, as the towing-path will have to be resurfaced after the balance of the work is completed. There will also be some increase in the cost on account of repairing four culverts, which were found to be in very dangerous condition.

CONTRACT No. 4.—ERIE CANAL.

Dated November 9, 1896, Gallo & McNeice, contractors.

Engineer's estimate	$33,251 00
Estimate at contract prices	31,590 05
Work, including 10 per cent. retained	25,980 00

This contract extends from lock No. 28 to lock No. 29, a dis-

tance of 1.97 miles. The plans provide for lowering the canal bottom two feet. This level receives the water from the Schoharie creek feeder.

The contractors made very slow progress as they immediately encountered a very tenacious hard-pan, which could only be excavated by blasting. They completed the vertical walls, about 50 per cent. of the slope wall, and about 50 per cent. of the excavation.

The cost of the work will exceed the estimate on account of rock excavation (hard-pan), and there will be an increase in the quantity of lining. The other quantities will remain about the same as estimated. The work can easily be completed during the coming winter.

CONTRACT No. 5.—ERIE CANAL.

Dated November 16, 1896, Brummelkamp & Lane, contractors.

Engineer's estimate	$90,532 65
Estimate at contract prices	88,434 35
Work done, including 10 per cent. retained	80,610 00

This contract extends from lock No. 32 to lock No. 33, a distance of 5.11 miles. The plans provide for lowering the canal bottom two feet.

The contractors completed the vertical walls, about one-half of the slope walls, repaired the Otsquago creek aqueduct and finished the prism excavation through the village of Fort Plain before the water was let into the canal last spring. The remaining portion of excavation is being done by dredging, and will

be practically completed before the close of navigation this season. Work on this contract will be completed during the coming winter.

The cost of this work will slightly exceed the estimate on account of the increase in the quantities of slope wall and lining for resurfacing the towing-path. There will also be some increase in the cost of excavation due to the large amount of ditching required to carry away the seapage from the canal.

CONTRACT No. 6.—ERIE CANAL.

Dated November 17, 1896, Lauer & Hagaman, contractors.

Engineer's estimate	$45,080 00
Estimate at contract prices	43,831 25
Work done including 10 per cent. retained	46,320 00

This contract extends from lock No. 33 to lock No. 34, a distance of 2.57 miles. The plans provide for lowering canal bottom two feet. This level receives water from Rocky Rift feeder.

The contractors have completed the vertical walls, about 80 per cent. of the slope walls, and 50 per cent. of the excavation. The cost of this work will exceed the estimate principally on account of the necessity of puddling the entire bottom of the prism for a distance of 3,000 feet, from the head of lock No. 33.

The excavation at this place uncovered a strata of very coarse gravel. It was decided to cover it with a layer of puddle one foot thick. This also increased the quantity of excavation as the cut had to be made one foot deeper.

There will also be an increase in the quantity of slope wall.

CONTRACT No. 7.—ERIE CANAL.

Dated November 11, 1896, John V. Quackenbush, contractor.

Engineer's estimate	$129,264 10	
Additional work authorized by canal board	17,741 20	
		$147,005 00
Estimate at contract prices		113,436 66
Final account		141,591 14

This contract includes the two levels between lock No. 42 and lock No. 44, a distance of 2.96 miles. The plans provided for raising the water surface one foot and lowering canal bottom one foot.

This contract is complete and final account rendered.

The additional work authorized by the canal board was for protecting 1,150 lineal feet of the berme bank between bridges Nos. 155 and 156 with piling; laying 2,113 lineal feet of sewers on Clark and North streets in the village of Ilion to carry away the seepage from the canal, which filled the cellars of the dwellings on those streets, and for the additional expense of raising and repairing locks Nos. 42 and 43. It was expected to lift the coping from the locks, lay a 12-inch course of masonry and replace the old stone, but the coping was dowelled into the masonry below and most of it was broken in lifting and had to be replaced by new stone.

There is an increase in the quanities of excavation, vertical wall and lining due to the necessity of obtaining material from borrow pits for raising the banks (classified as excavation) rebuilding some of the old vertical walls, which it was expected could be saved, and restoring the towing-path embankment where it crosses a marsh, between bridges Nos. 151 and 152. The embankment for a distance of about 600 feet settled bodily down

into the marsh and was restored by filling the space with gravel, which had to be hauled some distance and was classified as lining.

CONTRACT No. 11.—ERIE CANAL.

Dated September 7, 1896, Chambers & Casey, contractors.

Engineer's estimate	$116,396 00	
Additional work authorized by canal board	6,335 30	
		$122,731 30
Estimate at contract prices		96,303 90
Final account		118,239 73

This contract provided for lengthening locks Nos. 21 and 22 and enlarging the prism between said locks.

The contract is completed and final account rendered.

Chapter 320, Laws of 1895, appropriated $77,500 for lengthening these locks, but as the engineer's estimate exceeded this amount, the canal board authorized that the balance be paid from chapter 79 of the Laws of 1895.

The increase in the cost of the work above the estimate, was due principally to substituting concrete for piling under lock No. 22, some additional vertical wall, which it was found necessary to build at foot of lock No. 21 and repointing the old locks, and repairing the foundations, which were found to be undermined.

After the apron at the foot of lock 22 was removed, the rock underneath it was found to be much nearer the surface than expected. The soundings which were taken a short distance below the apron indicated an average depth to rock, of about nine feet, underneath the apron the depth proved to be only from four to six feet. As it was impracticable to use such short lengths of piles it was decided to excavate down to rock and build the entire foundation for the lock walls of concrete. This considerably

increased the cost but added greatly to the stability of the structure.

In repairing the unlengthened chamber of lock 21, it was found necessary to rebuild the apron which was badly undermined. The old dilapidated vertical wall, which extended from the foot of the lock to the mouth of Rexford Flats feeder, and which rested partially on the apron, had to be rebuilt. This stretch of vertical wall was included in contract No. 2, which extends from lock No. 20 to lock No. 21, but as the contractor on contract No. 2 did not have the material or plant on hand to do the work and it was imperative that it should be built before the opening of navigation, it was decided to have the work done under contract No. 11. The quantity of vertical wall on contract No. 2 will be correspondingly reduced.

CONTRACT No. 12.—ERIE CANAL.

Dated November 11, 1896, Shear & Haight, contractors.

Engineer's estimate	$84,740 00
Estimate at contract prices	79,320 50
Work done, including 10 per cent. retained	70,940 00

This contract extends from lock No. 22 to bridge No. 55, a distance of 3.29 miles. The plans provide for lowering the canal bottom two feet.

About 75 per cent. of the work on this contract is completed.

CONTRACT No. 13.—ERIE CANAL.

Dated November 10, 1896, John V. Quackenbush, contractor.

Engineer's estimate	$41,860 50
Estimate at contract prices	38,749 30
Final account	45,315 35

This contract comprised the level between lock No. 44 and lock No. 45, a distance of 1.24 miles. The plans provided for raising the water surface one foot and lowering canal bottom one foot.

The contract is completed and final account rendered.

There is an increase above the engineer's estimate in the quantities of excavation, embankment and vertical wall.

The increase in excavation is due to borrowing material for raising the banks. The increase in embankment was on account of excavated material which was necessarily hauled over one thousand feet, and the increase in the quantity of vertical wall was for rebuilding some old wall that could not be saved.

CONTRACT No. 8.—CHAMPLAIN CANAL.

Dated November 14, 1896, Whalen & Higgins, contractors.

Engineer's estimate	$66,270 00	
Additional work authorized by Canal Board	4,424 59	
		$70,694 59
Estimate at contract prices		58,376 00
Final account		89,940 41

This contract extends from a point 200 feet south of the Waterford sidecut to lock No. 5, a distance of 1.03 miles. The plan provided for lowering the canal bottom two feet. The water surface on this level is regulated by the height of the dam across the Mohawk river at Cohoes; the level is practically a continuation of the pond above said dam. This contract is completed and final account rendered.

The cost of the work on the contract proper exceeded the estimate by about $2,000. This was due to the large amount of excavated material through the village of Waterford that had to be hauled over 1,000 feet, which, under the specifications, was also classified as embankment.

The additional work authorized by the Canal Board was for extending the lock masonry at the side cut and for building a weir to regulate the flow of water at the old mill near the weigh-lock.

It was deemed best to build the approaches to the upper side-cut lock, which forms nearly a right angle to the canal, with dressed instead of rock-faced stone. This was classified as lock masonry and paid for under a special agreement.

The weir referred to is located at a water privilege dating from 1822, which allowed the owners to draw a certain quantity of water from the canal. The old weir was so constructed as to permit the use of a much larger quantity, and as it extended nearly to canal bottom, the entire level could be drained through it. In order to prevent this, it was decided to build a new weir that would meet the requirements of the grant and so constructed that the water in the level could not be drawn down low enough to impede navigation.

The main increase in the cost of the work on this contract was due to the necessity of restoring and strengthening the towing-path embankment between lock No. 5 and the Delaware and Hudson railroad bridge. The prism is excavated along a side hill of gravel formation. The towing-path bank is very high and rests on marshy ground. When the water was let into the canal the seepage through the gravel saturated the swamp and caused the bank to settle and slide. At one place for a distance of about 700 feet the towing-path dropped from 8 to 10 feet. The space was filled with gravel and the bank strengthened by piling and cribs filled with stone placed at the foot of slope. The contractors were paid for the actual cost of this work, with 10 per cent. addition on the item of labor for superintendence and use of tools.

CONTRACT No. 9.—CHAMPLAIN CANAL.

Dated November 10, 1896, John J. Whalen, contractor.

Engineer's estimate	$98,300 00
Estimate at contract prices	92,296 00
Final account	116,634 00

This contract extends from lock No. 7 to lock No. 8, a distance of three miles. The plans provided for raising the embankment so as to obtain a depth of seven feet of water above the old established canal bottom. This work was completed and final account rendered.

A portion of this work was on very treacherous ground, the banks settled considerably, requiring a large amount of extra material to restore them. It was also necessary to place heavy cribs filled with stone at the foot of the slope in many places to prevent them from sliding; this, with the addition of 1,500 cubic yards excavation of rock above the estimated quantity, accounts for the increase in the cost of the work over the engineer's estimate.

CONTRACT No. 10.—CHAMPLAIN CANAL.

Dated November 12, 1896, Mahan & Sundstrom, contractors.

Engineer's estimate	$245,188 76
Estimate at contract prices	214,317 52
Work including 10 per cent. retained	101,040 00

This contract extends from lock No. 15 to lock No. 16, a distance of 11.75 miles. The plans provide for lowering canal bottom two feet. This is the summit level of the Champlain canal and receives the water from the Glens Falls feeder. About 45 per

cent. of the vertical walls and 30 per cent. of the slope walls are finished. The excavation is being done by dredging and about 60 per cent. will be taken out this season.

The contractors expect to complete the walls during the winter and the excavation next season.

The following contracts have recently been awarded, but no work has been done on them up to the close of the fiscal year:

CONTRACT No. 15.—ERIE CANAL.

Dated September 23, 1897, Thomas H. Karr, contractor.

Engineer's estimate	$9,677 00
Estimate at contract prices	9,122 50

This contract extends from lock No. 29 to lock No. 30, a distance of .67 mile. The plan contemplates raising the present water surface one foot, and lowering present canal bottom one foot.

CONTRACT No. 16.—ERIE CANAL.

Dated September 21, 1897, J. V. Quackenbush, contractor.

Engineer's estimate	$225,335 00
Estimate at contract prices	181,998 00

This contract extends from lock No. 45 to the east line of Oneida county, a distance of 6.77 miles. The plan contemplates lowering the present canal bottom two feet.

CONTRACT No 17.—ERIE CANAL.

Dated September 23, 1897, Thomas H. Karr, contractor.

Engineer's estimate	$71,073 00
Estimate at contract prices	65,812 00

This contract extends from lock No 19 to lock No. 20, a distance of 2.71 miles. The plan contemplates raising the water surface one foot and lowering the present canal bottom one foot.

CONTRACT No. 18.—ERIE CANAL.

Dated October 13, 1897, Lauer & Hagaman, contractors.

Engineer's estimate	$91,905 00
Estimate at contract prices	97,301 00

This contract extends from lock No. 24 to lock No. 25, a distance of 3.8 miles. The plan contemplates raising the water surface one foot and lowering the present canal bottom one foot.

CONTRACT No. 19.—ERIE CANAL.

Dated September 16, 1897, Troy Public Works Co., contractors.

Engineer's estimate	$149,280 00
Estimate at contract prices	132,678 00

This contract extends from lock No. 25 to lock No. 27, a distance of 6.59 miles. The plan contemplates raising the water surace one foot and lowering the present canal bottom one foot.

CONTRACT No. 23.—ERIE CANAL.

Dated September 21, 1897, Clinton Beckwith, contractor.

Engineer's estimate	$68,208 00
Estimate at contract prices	53,000 00

This contract extends from lock No. 40 to lock No. 41, a distance of 2.64 miles. The plan contemplates raising the water surface one foot and lowering the present canal bottom one foot.

CONTRACT No 24.—ERIE CANAL

Dated September 21, 1897, J. V. Quackenbush, contractor.

Engineer's estimate	$74,450 50
Estimate at contract prices	59,290 00

This contract extends from lock No. 41 to lock No. 42, a distance of 2.86 miles. The plan contemplates raising the water surface one foot and lowering the present canal bottom one foot.

CONTRACT No. 27.—ERIE CANAL.

Dated September 21, 1897, Clinton Beckwith, contractor.

Engineer's estimate	$94,489 00
Estimate at contract prices	69,829 00

This contract extends from lock No. 39 to lock No. 40, a distance of 2.76 miles. The plan contemplates raising the present water surface one foot and lowering present canal bottom one foot.

The following contracts have been approved by the Canal Board, but have not yet been awarded:

CONTRACT No. 1.—ERIE CANAL.

Engineer's estimate	$175,356 75

This contract extends from lock No. 18 to lock No. 19, a distance of 8.86 miles. The plan contemplates raising the present water surface one foot and lowering the present canal bottom one foot.

CONTRACT No. 14.—ERIE CANAL.

Engineer's estimate	$289,626 00

This contract extends from lock No. 30 to lock No. 31, a distance of 13.84 miles. The plan contemplates raising the present water surface one foot and lowering present canal bottom one foot.

CONTRACT No. 20.—ERIE CANAL.

Engineer's estimate $143,225 00

This contract extends from lock No. 31 to lock No. 32, a distance of 6.31 miles. This plan contemplates raising the present water surface one foot and lowering present canal bottom one foot.

CONTRACT No. 21.—ERIE CANAL

Engineer's estimate $69,895 00

This contract extends from lock No. 34 to lock No. 35, a distance of 3.17 miles The plan contemplates raising the present water surface one foot and lowering canal bottom one foot.

CONTRACT No. 22.—ERIE CANAL.

Engineer's estimate $83,345 00

This contract extends from lock No. 35 to lock No. 36, a distance of 4.37 miles. The plan contemplates raising the present water surface one foot and lowering present canal bottom one foot.

CONTRACT No. 25.—ERIE CANAL.

Engineer's estimate $212,845 50

This contract extends from bridge No. 55 to lock No. 23, a distance of 3.6 miles The plan contemplates lowering the present canal bottom two feet.

CONTRACT No. 26.—ERIE CANAL.

Engineer's estimate	$22,334 00

This contract extends from lock No. 23 to lock No. 24, a distance of 0.79 miles. The plan contemplates raising the present water surface one foot and lowering canal bottom one foot.

CONTRACT No. 28.—CHAMPLAIN CANAL.

Engineer's estimate	$85,570 00

This contract extends from lock No. 20 to lock No. 21, a distance of 5.44 miles. The plans provide for lowering canal bottom one foot.

CONTRACT No. 29.—CHAMPLAIN CANAL.

Engineer's estimate	$38,294 00

This contract extends from lock No. 17 to lock No. 20, a distance of 6.8 miles, and covers the canalized portion of Wood creek. The plans provide for removing the bars and sediment from the creek bottom, the rock obstruction at the narrows and repairing the walls.

CONTRACT No. 30.—CHAMPLAIN CANAL.

Engineer's estimate	$30,897 00

This contract extends from lock No. 5 to lock No. 6, a distance of 1,400 feet, and also from lock No. 7 to lock No. 8, a distance of 1.32 miles. The plans contemplate raising the embankment and lowering canal bottom each one-half foot between locks Nos. 5 and 6, and lowering canal bottom one foot between locks Nos. 7 and 8.

CONTRACT No. 31.—CHAMPLAIN CANAL.

Engineer's estimate $37,994 15

This contract contemplates the rebuilding of arch culvert No. 12, and also the rebuilding of the Moses Kill aqueduct near lock No. 14.

Plans and estimates for the following contracts have not yet been submitted to the Canal Board:

CONTRACT No. 32.—CHAMPLAIN CANAL.

Engineer's estimate $90,000 00

This contract extends from the Mohawk river, at Cohoes, to the south side of the Waterford side cut, a distance of 1.04 miles. The plans contemplate lowering the present canal bottom to seven feet below the present water surface. (Water surface unchanged.)

CONTRACT No. 33.—CHAMPLAIN CANAL.

Engineer's estimate $120,000 00

This contract extends from lock No. 8 to lock No. 9, a distance of 4.10 miles.

The plan contemplates raising the present water surface 0.8 feet.

CONTRACT No. 34.—CHAMPLAIN CANAL.

Engineer's estimate $345,000 00

This contract extends from lock No. 9 to lock No. 10, a distance of 16 miles. The plan contemplates raising the present water surface one foot.

CONTRACT No. 35.—CHAMPLAIN CANAL.

Engineer's estimate $25,000 00

This contract extends from lock No. 10 to lock No. 11 (river level), a distance of 0.64 miles. The plan contemplates raising the present water surface one foot. This will make it necessary to raise the river dam one foot.

CONTRACT No. 36.—CHAMPLAIN CANAL.

Engineer's estimate $45,000 00

This contract extends from lock No. 11 to lock No. 12, a distance of 1.43 miles. The plan contemplates lowering the present canal bottom to seven feet below the present water surface. (Water surface unchanged.)

CONTRACT No. 37.—CHAMPLAIN CANAL.

Engineer's estimate $50,000 00

This contract extends from lock No. 12 to lock No. 13, a distance of 1.2 miles. The plan contemplates raising the present water surface one foot and six inches.

CONTRACT No. 38.—CHAMPLAIN CANAL.

Engineer's estimate $85,000 00

This contract extends from lock. No. 13 to lock No. 14, a distance of 2.7 miles. The plans contemplate raising the present water surface one foot and two-tenths.

CONTRACT No. 39.—CHAMPLAIN CANAL.

Engineer's estimate $260,000 00

This contract extends from lock No. 14 to lock No. 15, a distance of 5.5 miles. The plans contemplate raising the present water surface 1.3 feet.

It will also be necessary to rebuild lock Nos. 6 and 7—

Estimated cost $71,000 00

And lower the bottom of the lower side cut lock and deepen the channel from the lock to the river—

Estimated cost $20,000 00

CONTRACT No. 40—ERIE CANAL.

Engineer's estimate $97,520 00

This contract extends from lock No. 1 to lock No. 2, a distance of 1.24 miles. The plan contemplates lowering the present canal bottom one foot and raising the banks and present water surface one foot.

CONTRACT No. 41.—ERIE CANAL.

Engineer's estimate $101,085 00

This contract extends from lock No. 2 to the West Troy side cut, a distance of 4.57 miles. The plan contemplates lowering the present canal bottom two feet.

CONTRACT No. 42.—CHAMPLAIN CANAL.

Engineer's estimate $376,560 00

The plan contemplates changing present Champlain canal prism to the standard Erie canal dimensions between the junction of the two canals at West Troy and the guard lock at the south end of the Cohoes dam at the Mohawk river, a distance of 2.36 miles.

CONTRACT No. 43.—ERIE CANAL.

Engineer's estimate $120,500 00

This contract extends from the foot of lock No. 36 to the head of lock No. 37, a distance of 0.61 miles. The plan contemplates lengthening locks Nos. 36 and 37; also raising the towpath bank one foot and lowering the present canal bottom one foot.

CONTRACT No. 44.—ERIE CANAL.

Engineer's estimate $144,500 00

This contract extends from the head of lock No. 37 to the head of lock No. 39, a distance of 0.38 miles. The plan contemplates lengthening lock No. 38, lengthening lock No. 39, raising and lowering the level one foot between lock No. 37 and lock No. 38, and lowering the level between locks Nos. 38 and 39 two feet.

CONTRACT No. 45.—ERIE CANAL.

Engineer's estimate $106,000 00

The plans contemplate raising locks Nos. 18, 19, 24, 25 and 26 each one foot. Lowering lock No. 28 two feet and raising locks Nos. 23 and 29 each one foot, and lowering the bottom two feet.

CONTRACT No. 46.—ERIE CANAL.

Engineer's estimate $72,000 00

The plans contemplate raising locks Nos. 31, 35, 40 and 41 each one foot. Lowering lock No. 33 two feet and raising lock No. 34 one foot and lowering the bottom two feet.

CONTRACT No. 47.—ERIE CANAL.

Engineer's estimate $143,000 00

This contract extends from the Hudson river at West Troy through the West Troy side cut into the Erie canal, and thence to the foot of lock No. 3, a distance of 0.88 miles. The plan contemplates lowering the present canal bottom two feet and lowering the bottom of the lower side cut lock two feet.

CONTRACT No. 48.—ERIE CANAL.

Engineer's estimate $60,000 00

The plan for this contract contemplates building a steel trunk for the upper Mohawk aqueduct, the bottom of which shall be two feet lower than the bottom of the present structure.

CONTRACT No. 49.—ERIE CANAL.

Engineer's estimate $210,000 00

The plan contemplates connecting the Erie canal above lock No. 18 by means of a steel aqueduct with the contemplated steel lift lock at the Cohoes falls.

CONTRACT No. 50.—ERIE CANAL.

Engineer's estimate $490,000 00

The plan contemplates building a steel lift lock lifting from twenty feet below the present river bed below the Cohoes falls to the steel aqueduct.

CONTRACT No. 51.—ERIE CANAL.

Engineer's estimate	$332,420 00

The plan contemplates canalizing the Mohawk river by building an artificial channel between the foot of the lift lock and the guard lock at south end of Cohoes dam, where connection will be made with the present Champlain canal.

EXTRAORDINARY REPAIRS.

(Chapter 569, Laws of 1895.)

This act appropriated $20,000 for rebuilding the apron to the Rexford Flats dam. Plans were prepared and work advertised but as the bids greatly exceeded the appropriation, the work was not let. The Superintendent of Public Works, however, removed the old dilapidated fishway and pier at east end of the dam and rebuilt that portion of the dam occupied by the fishway and repaired the east abutment, which was badly undermined.

On August 23, 1896, the canal board set aside the sum of $9,424 from chapter 947, Laws of 1896, to be added to the unexpended balance of $13,149.48, and the work was again advertised. Owing to the risk involved on account of sudden freshets, the bids again exceeded the estimate, principally in the item of bailing and draining.

On June 24, 1897, the canal board set aside an additional sum from chapter 566, Laws of 1897, and the contract was let to Whalen & Higgins, September 14th. The contractors are now delivering material.

(Chapter 98, Laws of 1896.)

This act appropriated $5,000 for a new steel bridge over the Glens Falls feeder, at Glens Falls. This bridge replaced an old

structure which had been condemned. The contract was let to the Hilton Bridge Company, February 11, 1897, and was completed May first.

(Chapter 158, Laws of 1896.)

This act appropriated $2,000 to prevent the formation of ice gorges in the Racquette river at Raymondville, St. Lawrence county. After a careful examination of the situation, no practical method seemed apparent that could be carried out within the limits of the appropriation and on the strength of a petition, generally signed by the citizens of that village, it was decided to construct a crib dam across the river which would form a pond that would freeze over solid and thus prevent the flow of anchor ice which caused the trouble.

The contract for constructing the dam was let to William Coats, August 31, 1897. This work is now under way.

(Chapter 364, Laws of 1896.)

This act appropriated $5,000 for building a stone arch culvert at Second street, Waterford, over the stream flowing from the weigh lock. The contract was let to Michael Bennett September 5, 1896 and completed the following winter.

(Chapter 348, Laws of 1896.)

This act appropriated $5,000 for deepening and widening the canal between Shinnecock and Great South Bays in the county of Suffolk. The old channel was not of sufficient capacity to permit a free circulation of water between the two bays, which resulted in the waters at the upper end of Great South Bay becoming stagnant. This destroyed the fish and oyster industries, as well as being a menace to the health of the people living in that vicinity. Plans were prepared for dredging a channel 30 feet wide at bottom, 5 feet deep and with side slopes with 1½ to 1. The contract was let to P. J. Brummelkamp, December 7, 1896.

An additional appropriation of $5,000 was granted under chapter 790, Laws of 1897 for continuing the work.

(Chapter 947, Laws of 1896.)

This act appropriated $125,000 for the eastern division of the canals to be expended by the Superintendent of Public Works in extraordinary repairs and improvements to the mechanical and other constructions and works on the canals, out of this fund. The following work has been done by contract. Rebuilding lock No. 9, Champlain canal, contract awarded to J. J. Cunningham, September 26, 1896—work was completed May 1, 1897.

Repairs to steel dam across the Mohawk river at Cohoes. A portion of this structure which was built in 1893 was badly damaged by ice. The contract for restoring the same was let to Cunningham & Monty, October 5, 1896, and was completed January 1, 1897.

Rebuilding waste weir, Glens Falls feeder. This structure had been closed during the previous season leaving no means of controlling the water in the feeder, except through a small wicket near the guard lock. Contract was awarded to Jeremiah Adams, March 15, 1897, work completed May first.

Steel Road and Change bridge over the Erie canal at junction with the Champlain canal. This bridge replaced the old cast iron structure which had long been regarded as unsafe. Contract was awarded to the Hilton Bridge Company, March 1, 1897.

Steel bridge on three mile level, Champlain canal, known as Wilson's road bridge, and steel bridge on twelve mile level, Champlain canal, known as Farm bridge No. 102. These replaced old wooden bridges. They cost $660 and $630 respectively, which was about the cost of renewing the wooden structures. Contracts for the above were let to the Hilton Bridge Company, April 9, 1897.

(Chapter 949, Laws of 1896.)

This act appropriated $1,500 for repairs to Drake's draw-bridge over Wappinger creek, near New Hamburg, Dutchess county. By act chapter 239, Laws of 1892, this bridge became a State charge, the above appropriation was for repairing the bridge and improving the approaches thereto; contract was let to Oscar F. Hilt, April 29, 1897. Work is now under way.

(Chapter 105, Laws of 1897.)

This act appropriated $18,000 for building a lift bridge over the Erie canal at Railroad street in the village of Ilion. The contract was let to the Hilton Bridge Company, July 26, 1897. The work is now under way.

(Chapter 577, Laws of 1897.)

This act appropriated $4,000 for building a bridge and abutments over the side-cut at Fourth street in the village of Waterford. The contract was let to the Havana Bridge Works, September 30, 1897.

(Chapter 391, Laws of 1897.)

This act appropriated $15,000 for continuing the topographic survey of the State. The work is being done under the direction of the U. S. Geological Survey.

(Chapter 798, Laws of 1897.)

This act appropriated $7,500 for making surveys and maps for the Board of Claims under the direction of the attorney-general. Mr. T. C. Leutze has had charge of this work.

The accompanying tables show contracts completed and final estimates rendered during the year and contracts pending September 30, 1897.

Respectfully submitted,

DEWITT C. SMITH,

Division Engineer.

Middle Division.

SYRACUSE, N. Y., *September* 30, 1897.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor, Albany, N. Y.:*

Dear Sir.—In accordance with you instructions, I have the honor herewith to submit my annual report for the fiscal year ending September 30, 1897, so far as it relates to the work of improvement to the middle division of the Erie and Oswego canals.

The several parties as organized on October 1, 1896, were employed in completing surveys, maps, plans and estimates preparatory to placing the work under contract, and as this work was finished the engineering force was from time to time reduced temporarily until such time as the contractors commenced work under their contracts, since which time the force has been gradually increased as necessity required.

It has been my aim to keep the force and expenses at a minimum in accordance with your instructions, but during the coming winter the force must be largely augmented in order that the contractors may not be delayed in the prosecution of their work.

In order that a full understanding of the condition of the work upon each contract and the difficulties that have been encountered upon much of the work, the following statement is submitted for your further information.

CONTRACT No. 1.

Dated, November 19, 1896. Thomas J. Dwyer & Company, contractors.

Engineer's estimate	$136,468 00	
Additional work authorized by canal board	686 00	
		$137,154 00
Estimate at contract prices........................		125,520 00
Work done including 10 per cent. retained........		165,270 00

This contract extends from the east line of Oneida county, to a point 100 feet below the hollow quoin of lock No. 46, a distance of 3.33 miles.

The contractors commenced work promptly after the execution of the contract and prosecuted it diligently until the opening of navigation last spring, since which time the work done was mostly confined to the delivery of material for future use.

The plan adopted provides for lowering canal bottom two feet the entire length of the Utica level, as being more economical than raising the surface, on account of the many bridges that would require raising and the probable damage to property in the city of Utica, from flooding cellars and disarranging streets and business blocks. The excavation of prism is about 5-6 completed.

The work will when completed largely exceed the engineer's estimate for the following reasons. The rock classification, mostly hard-pan that cannot be plowed, will show an increase of 35,000 cubic yards. Embankment will probably be increased 75,000 cubic yards, owing to the fact that material excavated and necessarily moved over 1,000 feet is allowed under the speci-

fications as embankment, and in the city of Utica no land for spoil-banks could be secured for over half the material excavated.

The items of vertical wall and concrete will be increased largely. It was expected that the old vertical wall could be preserved by under pinning with concrete, and much of the old wall was so treated before it was discovered that the wall was simply a veneer of stone without bond or backing and would not stand its own weight, and for a long distance the wall fell into the prism just before the canal navigation opened, and this wall will have to be rebuilt.

The property owners having business connections with the canal are clamoring for vertical wall where none has heretofore existed; to what extent their demands will be granted, will develop before the contract is completed.

Items of extra work not provided for in the contract amounting to $5,219.38 have been passed upon and allowed.

These are the principal items of increase which were not provided for in the estimate prepared for letting the work.

The work under this contract will be completed the coming winter.

CONTRACT No. 2.

Dated, November 17, 1896. McDonald & Sayre, contractors.

Engineer's estimate	$185,078 30	
Additional work authorized by canal board	21,811 56	
		$206,889 86
Estimate at contract prices........................		148,948 80
Work done including 10 per cent. retained........		200,070 00

This contract extends from a point 100 feet below the lower hollow quoins of lock No. 49, to a point 100 feet below the lower hollow quoins of lock No. 50, a distance of 4.94 miles.

Work under this contract has been vigorously prosecuted by the contractors and a comparatively small amount of work yet remains to be done.

The plan adopted for improving the Syracuse level is the same as described on contract No. 1, and for same reasons the work will materially exceed the original estimate in items of excavation of rock and embankment. While the old vertical wall upon this contract is better than upon contract No. 1, a considerable quantity was too poor to stand undermining preparatory to underpinning and had to be rebuilt.

The old timber docking on top of vertical walls will be replaced with stone coping, and the towing path subgraded and relined by direction of the Superintendent of Public Works Department.

The work included in this contract will easily be completed the coming winter.

ADDITIONAL WORK AUTHORIZED BY CANAL BOARD.

This item occurred in contracts 1, 2, 3, 4 and 5, to so large an extent that an explanation is this connection will be proper.

The work accomplished last winter in excavation of silt and puddling from the prism, opened up many leaks in embankments, some of which were extremely dangerous. After full discussion of the question of how to stop the leaks, it was decided as the only feasible plan, to drive tripple lap sheet piling through the banks at the points developing the worst leaks. After the first trial it was evident that the best plan had been selected. Estimates were made and approved by the State En-

gineer and Surveyor and the Superintendent of Public Works and adopted by the canal board, as a change of plan. This character of work will without doubt be found necessary on other contracts and will have to be provided for as the emergency developes. In the original estimates, no provision was made for this work as it was not known to what extent if any, leaks would develop.

CONTRACT No. 3.

Dated, November 14, 1896. John Dunfee and Company, contractors.

Engineer's estimate	$127,780 50	
Additional work authorized by canal board	33,759 62	
		$161,540 12
Estimate at contract prices		136,842 00
Work done including 10 per cent. retained		153,470 00

This contract extends from a point 100 feet west of upper hollow of lock No. 50 to a point 100 feet west of center of Camillus road bridge, a distance of 3.92 miles.

The plan adopted for improving this contract contemplates lowering the bottom of the prism one foot and raising the surface one foot.

The work on this contract is nearly completed, from the east end of the contract of nine mile creek aqueduct. West of that point the prism is not entirely excavated and the top of banks are yet in an unfinished state.

Camillus feeder is bottomed out for about three-quarters of its length. The feeder dam and bridge are completed, and the new culvert under feeder to carry off water from the swamp south of the canal is finished, as is the ditch leading thereto.

The bridges are all raised but one, and the masonry completed. The amount of work remaining to be done on this contract is so small, that it will easily be completed the coming winter.

CONTRACT No. 4.

Dated, November 14, 1896. John Dunfee and Company, contractors.

Engineer's estimate	$138,931 50	
Additional work authorized by canal board	70,460 00	
		$209,391 50
Estimate at contract prices		154,471 00
Work done including 10 per cent. retained		259,570 00

This contract extends from a point 100 feet west of Camillus road bridge to a point 100 feet west of Peru road bridge, a distance of 6.31 miles through the summit swamp.

In preparing the preliminary estimate for contracts Nos. 3, 4 and 5, consisting of the Jordan level, the conditions and difficulties to be encountered to lower the prism one foot were not understood and could not have been anticipated. For about 5 miles the canal is cut through a swamp, the surface of adjoining land is several feet above surface of water in the canal and upon either bank the material originally excavated was deposited forming heavy banks. The surface soil is muck, underneath which is quicksand and marl reaching in some places 40 feet in depth below canal bottom. The surface of the swamp being high enough, was drained into the canal as no other remedy has been provided; in order to do the work in the prism all these streams had to be closed, thus allowing the swamps to fill with water. As a result the whole mass of marl and quicksand became soapy to such an extent that the material in the bottom of the prism would

raise faster than it could be removed with modern dredges. The heavy spoil banks settled, raising the prism and carrying down the towing-path and old slope wall and the bench on which it rested on the berme side. About one-half of the length of the contract has been excavated and slope-walls built. Just before the opening of the canal, the towing-path settled several feet and the only remedy available was adopted by bridging with material on hand and planking the surface for a towing-path. The most difficult portion of the work is yet to be done. How to change the conditions to enable the contractors to do the work was a question of serious moment. After a thorough conference with the State Engineer and Superintendent's department, it was finally agreed that,

First. The swamps must be drained.

Second. That in order to form a foundation for slope-wall and to prevent the material raising in the prism at each side from the weight of the heavy spoil banks upon both sides of the canal, it was decided to drive a close row of piles at the toe of slope-wall through the soapy material into the underlaying strata of hard material ranging from 15 to 40 feet upon which as a foundation the slope wall will be built.

In order to drain the swamp, it was decided to construct a culvert under the nine mile creek feeder on contract No. 3, to give an outlet into nine mile creek, and excavate ditches upon both sides of the canal through the swamp covered with timber of sufficient capacity to drain the swamp without allowing it to enter the canal. This work and the piling not contemplated at time of making the estimate will cost about $80,000.

The material in the prism in much of the distance completed was quadrupled from raising. Slope and vertical walls and

bridge abutments after completion would slide into the canal and have to be relaid, some times more than once. The troubles encountered upon this contract are so serious and various, that an attempt at description will give but an incomplete idea of their magnitude, and an approximate estimate of the final cost of the work cannot now be made; but if the result from ditches and pile protection proves all that is anticipated, the work to complete the contract will be comparatively easy and will be done without doubt, the coming winter.

I have prepared the foregoing statement not as a justification of the cost of work under this contract in excess of the estimate made prior to letting the work, but as a matter of history of the most difficult work in all its surroundings upon the canals of this State, and I know that this effort falls far short of doing full justice.

CONTRACT No. 5.—ERIE CANAL.

Dated, November 14, 1897. John Dunfee and Company, contractors.

Engineer's estimate	$141,444 50	
Additional work authorized by canal board	23,798 00	
		$165,242 50
Estimate at contract prices		150,614 40
Work done including 10 per cent. retained		128,530 00

This contract extends from a point 100 feet west of the center of Peru road bridge to a point 100 feet west of the lower hollow quoin of lock No. 51, a distance of 4.68 miles.

The work upon this contract is well advanced, but a small portion of the excavation of the prism and raising banks and walls remains to be done.

The culvert at Carpenter brook gave considerable trouble last winter in consequence of high water in the creek raising the covering timbers and flooding the work in progress on contracts Nos. 4 and 5. This is a composite culvert of three spaces 3 by 4 feet each, and is entirely inadequate to carry the stream in high water. This structure should be rebuilt with three cast iron pipes 42 inches in diameter and the ditch below bottomed and enlarged so as to allow free flow instead of over a breast wall four feet high. An additional estimate for this work will be prepared for submission to the Honorable, the Canal Board, at an early day.

After opening of navigation last spring, the banks between Jordan and lock No. 51, leaked badly and a break was feared unless protected by sheet piling. An estimate of cost was prepared amounting to $23,798, and the work was authorized by the Honorable, the Canal Board, and has been done, removing all danger.

This contract will be completed by the opening of navigation next spring.

CONTRACT No. 6.—OSWEGO CANAL.

Dated December 8, 1896, Dodge & McGregor, contractors.

Engineer's estimate	$14,497 00
Estimate at contract prices......................	12,206 00
Work done, including 10 per cent. retained........	10,840 00

This work consists of building a stone apron to a portion of Phoenix dam and work connected therewith.

The apron will be cut stone, 30 inches deep and 20 feet in width, and new steel bulkheads to supply the mills with water in place of the old wooden structures.

The work of inserting the new bulkheads is completed and the cut stone for the apron is on the ground. The work preparatory to laying is being done.

The use of this dam so long after the timber apron was carried away has, from the action of the water, become badly undermined, and is in a precarious condition, and the apron must be completed before high water occurs in the river or the whole dam may be carried away.

CONTRACT No. 7.—OSWEGO CANAL.

Dated October 1, 1896, John Kelley & Co., contractors.

Engineer's estimate	$12,618 00
Estimate at contract prices	10,695 00
Work done, including 10 per cent. retained	5,020 00

This work consists of raising Braddock's dam and work connected therewith.

The spillway of the dam will be raised 1.25 feet with new stone coping. All abutments and piers will be raised, and the head of guard lock No. 4 has been raised and new gates inserted.

The dressed stone for the entire work is prepared and all will be laid this season, except on the spillway, which will probably have to go over until next year.

CONTRACT No. 8.—OSWEGO CANAL.

Dated November 16, 1896, John Kelley & Co., contractors.

Engineer's estimate	$15,333 00
Estimate at contract prices	13,425 50
Work done, including 10 per cent. retained	9,290 00

This work consists of raising Minetto dam and work connected therewith.

The spillway of the dam will be raised about 1.25 feet with new stone coping. All abutments, piers and the head of lock No. 13 have been raised, and the new gates inserted at the head of the lock.

New steel bulkheads have been put in place and the necessary guard banks are in process of construction.

All the work under this contract will be done this season except laying coping on the spillway, which will probably go over until next year.

CONTRACT No. 9.—OSWEGO CANAL.

Dated November 16, 1896, John Kelley & Co., contractors.

Engineer's estimate	$20,049 00
Estimate at contract prices	17,801 00
Work done, including 10 per cent. retained	12,730 00

This work consists of raising High dam and work connected therewith. The spillway of the dam will be raised about two feet with new stone coping, and the abutments and piers and head of lock No. 15 have been raised and new gates inserted in head of lock. New steel bulkheads have been put in place. The necessary guard banks will be built. The stone for coping of spillway is all dressed and mostly delivered.

It is expected that all the work under this contract will be completed this fall, except raising the spillway.

The stone for raising the three dams under contract with John Kelley & Co. are to be procured at Sugar river on Black River canal; orders were repeatedly given to the contractors to increase their force so as to insure the delivery of all the stone at the work by September 1st, which would be in time to complete

the work by December 1st, but the work was allowed to drag along and when the break in the Forestport feeder occurred on July 23d, thereby closing the Black River canal for one month, a large proportion of the stone were undelivered, and after reopening the canal it was too late to deliver them at the dams and set them this season.

The stone will all be delivered before the close of navigation and placed in the work next season. Had the contractors complied with the orders given them, the work could have been completed this season.

CONTRACT No. 10.—OSWEGO CANAL.

Dated November 20, 1897, Hughes Bros. & Bangs, contractors.

Engineer's estimate	$48,058 00
Estimate at contract prices	51,370 50
Work done, including 10 per cent. retained	35,940 00

This work consists of raising Oswego dam and work connected therewith. The work connected therewith consists of a new bulkhead complete with stone abutments and piers and steel gate frames and gates at the head of the hydraulic canal on the east side of the river, repairing inlet culvert on towing-path above guard lock No. 5, raising head of guard lock No. 5 and insertion of new gates, raising division wall between lock and dam, raising spillway of dam about 2.25 feet and raising walls to lock at the entrance to the Varick canal and insertion of new gates, and new steel bulkheads on the west side of the river, all to be raised to proper height to hold back high water.

This work is nearly completed and will be entirely finished within thirty days, except coping on the dam, which will probably have to remain until next season.

In explanation of the disparity between engineer's estimate and estimate at contract prices, the item of coping was changed after the estimate was made from limestone to granite, increasing the cost of the work about $9,000.

All the work thus far done on the several dams is of the most substantial character.

CONTRACT No. 11.—OSWEGO CANAL.

Dated November 18, 1896, Randerson & Seward, contractors.

Engineer's estimate	$36,571 00
Estimate at contract prices	30,345 45
Final account	32,182 28

This contract provides for "improving Lake Ontario level from a point 100 feet below the lower hollow quoins of lock No. 18 to a point in the bottom of the harbor at Oswego, 10 feet below U. S. datum."

This work was done during the past winter and spring, giving full ten feet of water below low water in Lake Ontario, as fixed by the U. S. Engineering Department.

As water in Lake Ontario at times gets somewhat below the U. S. benchmark, it was deemed safe to provide for ten feet of water. The harbor work was done by under-water blasting, and removal of the rock by dredging, and paid for as wet excavation of rock.

From the harbor line to lock No. 18 the pit was pumped and rock removed as dry excavation of rock.

CONTRACT No. 12.—ERIE CANAL.

Dated November 19, 1896, Thomas J. Dwyer & Co., contractors.

Engineer's estimate	$16,482 00
Estimate at contract prices	16,195 50
Final account	18,751 15

This contract provides for "improving lock No. 46 and work connected therewith."

Owing to the reduction of the bottom of prism on the Utica and Syracuse levels of two feet, it became necessary to lower locks Nos. 46, 49 and 50, two feet. To do this work without taking up the entire lock and lowering the foundation and rebuilding the locks at great expense, it was decided, after careful study, making several plans, to adopt the plan herewith submitted, thus making a saving of at least $250,000. While the plan was somewhat novel, and many thought hazardous, the result has fully justified the saving.

The contractors performed this work with great care, and no fear is entertained for the safety of the structures.

This work slightly exceeded the estimate, principally owing to conditions discovered in the foundations, which were not anticipated and it was imperatively necessary they should be corrected in order that the locks be preserved.

CONTRACT No. 13.—ERIE CANAL.

Dated November 20, 1896, Hughes Bros. & Bangs, contractors.

Engineer's estimate	$16,193 50
Estimate at contract prices	15,352 00
Work done, including 10 per cent. retained	15,570 00

This contract provides for "improving lock No. 49 and work connected therewith."

The work consisted of lowering foundation two feet, as in contract No. 12. The work is nearly completed, there remaining only raising the banks and vertical walls at head and foot of the lock.

The work will slightly exceed the engineer's estimate, from the necessity of building vertical wall at foot of lock, in excess of amount estimated.

CONTRACT No. 14.—ERIE CANAL.

Dated November 16, 1897, John Kelley & Co., contractors.

Engineer's estimate	$16,447 00
Estimate at contract prices	15,357 00
Final account	17,867 05

This contract provided for "improving lock No. 50 and work connected therewith."

The work consisted of lowering foundation two feet, as in contracts Nos. 12 and 13, and is completed and settled.

Some work developed that was not anticipated, which slightly increased the cost over the Engineer's estimate.

The usual 10 per cent. allowed for contingencies has not been included in any estimate for improvement work.

CONTRACT No. 15.—OSWEGO CANAL.

Dated November 16, 1896, Walter Bradley, contractor.

Engineer's estimate	$66,144 00
Estimate at contract prices	62,191 40
Work done, including 10 per cent. retained	20,160 00

This contract provides for rebuilding and lengthening lock No. 18 and other work connected therewith.

The work consists of taking up the present lock, lowering foundation to grade, establishing ten feet of water below U. S. low-water benchmark, and building double-length lock.

The work done thus far consists in preparing and delivering material. As soon as navigation closes the work will be commenced, and must be completed before the opening of navigation next spring.

CONTRACT No. 16.—OSWEGO CANAL.

Dated December 7, 1896, Edwin Lodder, contractor.

Engineer's estimate	$67,500 00
Estimate at contract prices	73,925 00
Final account	100,075 15

This contract extends from a point 100 feet below the lower hollow quoin of guard lock No. 3 to a point 100 feet above the upper hollow quoin of lock No. 11, a distance of 2.51 miles.

This work is completed and final account rendered. Owing to a rearrangement of the level, made necessary by the final decision to raise Oswego Falls dam after this work was let and in progress, work under this contract was increased by raising banks and walls, but the work on the level above will be reduced in consequence of raising the dam. Another item of increase consists of rebuilding vertical wall where it failed during the prosecution of the work. There is much more vertical wall which should be rebuilt, as it is in very bad condition and is liable to fall at any time As it may stand a year or two, it was decided to let it remain, although the people of Fulton much desired a further extension of new wall.

If any portion of the old wall is yet to be rebuilt, it should be done from other funds, as the wall has in no way been affected by the improvement.

CONTRACT No. 17.—ERIE CANAL.

Dated December 14, 1896, Owego Bridge Co., contractors.

Engineer's estimate	$11,236 00
Estimate at contract prices	8,893 00
Work done, including 10 per cent. retained	8,840 00

This contract provides for rebuilding Canasaraga Creek culvert. The old culvert has ten spaces 2½ x 4 feet of composite construction, much too small to carry the stream in time of high water.

The new structure is of stone, brick and steel, of five spaces 8 feet 2 inches by 3 feet 6 inches.

The breast wall at the lower end is removed, and the creek channel below lowered and enlarged to permit the free flow of water, doing away with the filling of culvert with gravel as much as possible.

CONTRACT No. 18.—ERIE CANAL.

Dated March 19, 1897, O'Brien & Hoolihan, contractors.

Engineer's estimate	$96,373 00	
Additional work authorized by Canal Board	31,355 00	
		$127,728 00
Estimate at contract prices		91,794 50
Work done, including 10 per cent. retained		106,450 00

This contract extends from a point 100 feet above the upper hollow quoin of lock No. 46 to a point 100 feet west of the center of Oriskany Creek aqueduct, a distance of 5.95 miles.

The work under this contract is well advanced. The prism excavation is completed for a distance of over three miles, the towing path and walls raised and the berme bank and wall are well advanced.

Triple lap sheet piling, to stop leaks, has been driven in the towpath banks to the extent authorized by the Canal Board.

CONTRACT No. 19.—ERIE CANAL.

Dated March 19, 1897 O'Brien & Hoolihan, contractors.

Engineer's estimate	$106,322 50	
Additional work authorized by Canal Board	30,948 00	
		$137,270 50
Estimate at contract prices		105,053 50
Work done, including 10 per cent. retained		65,630 00

This contract extends from a point 100 feet west of Oriskany Creek aqueduct to a point 100 feet west of Greenfield's road bridge, a distance of 6.67 miles.

The work done under this contract has been confined to raising banks and walls above water, raising bridges, etc. The prism will be bottomed out during the coming winter.

CONTRACT No. 20.—ERIE CANAL.

Dated August 17, 1897, Warren-Scharf Asphalt Paving Co., contractors.

Engineer's estimate	$246,653 00
Estimate at contract prices	242,757 55
Work done, including 10 per cent. retained	3,230 00

This contract extends from a point 100 feet west of Greenfield's road bridge to a point 100 feet west of Main street road bridge at New London, a distance of 8.45 miles.

The work under this contract has barely commenced. The contractors are making arrangements to procure materials preparatory to a vigorous prosecution at once.

CONTRACT No. 21.—ERIE CANAL.

Dated August 17, 1897, Warren-Scharf Asphalt Paving Co., contractors.

Engineer's estimate	$218,247 00
Estimate at contract prices	212,945 45

This contract extends from a point 100 feet west of Main street road bridge, at New London, to a point 100 feet west of Durhamville road bridge, a distance of 8.31 miles.

No work has been done under this contract other than making preparations to procure materials.

CONTRACT No. 22.—ERIE CANAL.

Dated August 6, 1897, National Contracting Co., contractors.

Engineer's estimate	$247,465 00
Estimate at contract prices	232,307 50

This contract extends from a point 100 feet west of Durhamville road bridge to a point 100 feet west of New Boston road bridge, a distance of 9.04 miles.

No work has been done under this contract.

CONTRACT No. 23.—ERIE CANAL.

Dated August 23, 1897, E. H. Gaynor, contractor.

Engineer's estimate	$165,897 00
Estimate at contract prices	147,582 00
Work done, including 10 per cent. retained	2,340 00

This contract extends from a point 100 feet west of New Boston road bridge to a point 100 feet west of Kirkville road bridge, a distance of 7.20 miles.

The contractor has barely commenced work, delivering materials and making preparations to proceed at once at such work as can be done before the close of navigation.

CONTRACT No. 24.—ERIE CANAL.

Dated August 6, 1897, National Contracting Co., contractors.

Engineer's estimate	$142,051 00
Estimate at contract prices	136,720 00
Work done, including 10 per cent. retained	1,420 00

This contract extends from a point 100 feet west of Kirkville road bridge to a point 100 feet east of Butternut creek aqueduct, a distance of 5.86 miles.

So little work has been done under this contract that it may be said as just commenced. Provisions are being made to prosecute with vigor from this time forward.

CONTRACT No. 25.—ERIE CANAL.

Dated August 6, 1897, National Contracting Co., contractors.

Engineer's estimate	$140,680 00
Estimate at contract prices	127,750 00
Work done, including 10 per cent. retained	1,150 00

This contract extends from a point 100 feet east of Butternut creek aqueduct to a point 100 feet east of the upper hollow quoin of lock No. 49, a distance of 5.30 miles.

The contractors have but just commenced their work, but show satisfactory indications of a determination to push their work to an early completion.

CONTRACT No. 26.—ERIE CANAL.

Dated August 5, 1897, John Dunfee & Co., contractors.

Engineer's estimate	$145,452 00
Estimate at contract prices	136,600 00
Work done, including 10 per cent. retained	9,700 00

This contract extends from a point 100 feet west of the lower hollow quoin of lock No. 51 to a point 100 feet west of Centerport road bridge, a distance of 5.56 miles.

The contractor has commenced work with great energy, furnishing materials and raising banks.

CONTRACT No. 27.—ERIE CANAL.

Dated August 18, 1897, W. B. Priddy, contractors.

Engineer's estimate	$125,869 00
Estimate at contract prices	115,713 00
Work done, including 10 per cent. retained	9,640 00

This contract extends from a point 100 feet west of Centerport road bridge to a point 100 feet west of Crane brook aqueduct, a distance of 5.03 miles.

The contractor commenced the work promptly on execution of the contract, delivering materials, excavating ditches and raising banks.

CONTRACT No. 28.—ERIE CANAL.

Dated August 19, 1897, Andrew Onderdonk, contractor.

Engineer's estimate	$172,430 00
Estimate at contract prices	167,216 00
Work done, including 10 per cent. retained	11,310 00

This contract extends from a point 100 feet west of Crane brook aqueduct to the east line on Wayne county, a distance of 6.24 miles.

A large force was put to work on this contract soon after execution of contract, raising banks across Cayuga marshes and furnishing materials.

CONTRACT No. 36.—OSWEGO CANAL.

Dated, September 30, 1897. Edwin Lodder, contractor.

Engineer's estimate	$51,057 00
Estimate at contract prices	48,447 00

This contract consists of raising the towpath from lock No. 7, to guard lock No. 3, and work connected therewith, a distance of 3.56 miles.

This work having been let on the last day of the fiscal year, no work has been done.

CONTRACT No. 37.—OSWEGO CANAL.

Dated, August 30, 1897. Willard Johnson, contractor.

Engineer's estimate	$13,836 00
Estimate at contract prices	15,382 00

This contract consists of raising Oswego Falls dam, and work connected therewith.

The contractor has made arrangements for procuring material and will prosecute such work as can be done this fall, and be ready to lay the masonry next spring.

The following contracts have not been let at the close of the fiscal year, but are inserted here to make the record of all contracts complete.

CONTRACT No. 29.—OSWEGO CANAL.

Engineer's estimate $75,370 00

This contract will extend from the junction of the Oswego canal with the Erie canal at Syracuse, to a point 100 feet below lower lock quoin of lock No. 3, a distance of 1.98 miles.

CONTRACT No. 30.—OSWEGO CANAL.

Engineer's estimate $120,000 00

This contract will extend from a point 100 feet below lower hollow quoin of lock No. 3, to a point 100 feet above the upper hollow quoin of lock No. 5 (Mud lock), a distance of 5.42 miles.

CONTRACT No. 31.—OSWEGO CANAL.

Engineer's estimate $20,000 00

This contract will consist of improving lock No. 5, including work connected therewith, extending from a point 100 feet above the upper hollow quoin to a point 100 feet below lower hollow quoin, a distance of .0795 mile.

CONTRACT No. 32.—OSWEGO CANAL.

Engineer's estimate $235,000 00

This contract will extend from a point 100 feet below the lower hollow quoin of lock No. 5, to a point 100 feet above the upper hollow quoin of guard lock No. 1, at Phoenix.

CONTRACT No. 33.—OSWEGO CANAL.

Engineer's estimate $20,000 00

This work consists of improving guard lock No. 1, including work connected therewith, extending from a point 100 feet above the upper hollow quoin to a point 100 feet below the lower hollow quoin, a distance of .0795 mile.

CONTRACT No. 34.—OSWEGO CANAL.

Engineer's estimate $136,885 00

This contract will extend from a point 100 feet below the lower hollow quoin of guard lock No. 1, to end of lower wing of lock No. 7, a distance of 5.73 miles.

CONTRACT No. 35.—OSWEGO CANAL.

Engineer's estimate $35,000 00

This contract will consist of dredging channel from ends of lower wings of lock No. 7, to guard lock No. 3, a distance of 3.52 miles.

CONTRACT No. 38.—OSWEGO CANAL.

Engineer's estimate $125,000 00

This contract will extend from a point 100 feet above the upper hollow quoin of lock No. 11, to a point 100 feet above the upper hollow quoin of lock No. 13, a distance of 4.90 miles.

CONTRACT No. 39.—OSWEGO CANAL.

Engineer's estimate $35,000 00

This contract will consist of improving and lengthening lock No. 13, including work connected therewith, extending from a point 100 feet above the upper hollow quoin of lock No. 13, to a point 210 feet below the lower hollow quoin of the present lock, a distance of .0795 mile.

CONTRACT No. 40.—OSWEGO CANAL.

Engineer's estimate $106,000 00

This contract will extend from a point 100 feet below the lower hollow quoin of the lengthened lock No. 13 to a point 100 feet above the upper hollow quoin of lock No. 18, excepting therefrom contract No. 46 and the lengthening and improving of locks Nos. 14, 15, 16, 17 and guard lock No. 5, together with the work connected therewith, a distance of 3.06 miles.

CONTRACT No. 41.—OSWEGO CANAL.

Engineer's estimate $35,000 00

This contract will consist of improving and lengthening lock No. 14, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of present lock, to a point 100 feet below the lower hollow quoin, a distance of .0795 mile.

CONTRACT No. 42.—OSWEGO CANAL.

Engineer's estimate $35,000 00

This contract will consist of improving and lengthening lock No. 15, and work connected therewith, extending from a point 100 feet above the upper hollow quoin to a point 210 feet below the lower hollow point of the present lock, a distance of .0795 mile.

CONTRACT No. 43.—OSWEGO CANAL.

Engineer's estimate $35,000 00

This contract will consist of improving and lengthening lock No. 16, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of the present lock to a

point 100 feet below the lower hollow quoin, a distance of .0795 mile.

CONTRACT No. 44.—OSWEGO CANAL.

Engineer's estimate	$35,000 00

This contract will consist of improving and lengthening guard lock No. 5, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of the present lock to a point 100 feet below the lower hollow quoin, a distance of .0795 mile.

CONTRACT No. 45.—OSWEGO CANAL.

Engineer's estimate	$35,000 00

This contract will consist of improving and lengthening lock No. 17, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of the present lock to a point 100 feet below the lower hollow quoin, a distance of .0795 mile.

CONTRACT No. 46.—OSWEGO CANAL.

Engineer's estimate	$16,860 00

This contract will extend from station 1026, near lock No. 16, to station 1068, near guard lock No. 5, a distance of one mile.

This contract will soon be let.

CONTRACT No. 47.—ERIE CANAL.

Engineer's estimate	$12,425 00

This contract will consist of improving and repairing Crane Brook aqueduct, extending from a point 100 feet east to a point 100 feet west of the end of the trunk, a distance of 272 feet.

This work will be let soon and consists of repairing foundation and masonry and the construction of a new steel trunk.

The foregoing statement of the progress and condition of the work under each contract has been prepared to exhibit in as concise a manner as possible without extending this report to an unreasonable length, yet it seems that attention may properly be called in a general way to difficulties and contingencies that always arise in repairing old dilapidated work of any kind, and the canal is no exception. Care was taken in making the preliminary surveys and estimate to cover work in sight necessary to be done to carry out the spirit of the law authorizing the improvement of the Erie and Oswego canals, and before letting the work, the preliminary estimate was arbitrarily cut, as it was thought the work could be finished within the reduced quantities. So far as the work has progressed it has become evident that the first estimate was not excessive. As the work progresses many conditions arise that could not be foreseen and were not provided for. Much of the vertical and slope walls were buried in silt, which when removed and one additional foot taken from the bottom of the prism, are found instable and to a large extent had to be rebuilt. The material, particularly on the Jordan level as explained on contracts Nos. 3, 4 and 5, was excavated several times and yet it was with the utmost difficulty that the prism and towing-path could be put in condition last spring for navigation and the cost of such work must be paid for, greatly enhancing the cost of the work.

By excavating the deposit of long accumulation from the prism and generally one foot below old canal bottom causes leaks in the banks in very many places to a dangerous point and always to the damage of the adjoining land which must be stopped or breaks are liable to occur besides innumerable claims for damages to adjoining property will be filed with the court of claims. The

most feasible plan for stopping these leaks is by driving triple lap sheet piling in the banks to such a depth as may be necessary.

Culverts to some extent have been rebuilt, creek channels lowered and enlarged, side ditches opend, aqueducts repaired and where the trunks on careful examination are found too much decayed to carry the additional depth of water, must be rebuilt. All such work costs money and where extended over the whole of the division amounts to large sums.

This department is in full sympathy with the Superintendent of Public works in a desire to keep the cost of the work as low as possible, yet as an engineering proposition nothing should be omitted to be done that will leave the canals in dangerous condition. One break might cost for repairs and damages to boatmen more than the additional cost of protection of the whole division. Upon this theory the division engineer has kept the future of the canal constantly in mind, believing that his professional reputation and the interest of the State would be in jeopardy by an opposite course.

Another large item of increased cost occurs from the fact that the material excavated from the prism in the winter has been found entirely unfit to raise the banks and new material must be secured for the top of the banks. An effort was made last winter to use the material (mostly silt) taken from the prism in raising banks as per original estimate and it was impossible to get teams over banks so raised. Any lining put on would mix at once with the soft material below, and make the towing-path utterly impassable. The material of this nature put on had to be removed before the opening of navigation and used in the back slopes of banks or wasted where not so required. This involves no changing of plan, but as navigation must be maintained, the soft mate-

rial from the prism could not be used, and the expense of procuring other material for embankment increased the cost of the work to that extent.

With this explanation, it can easily be seen that most of the contracts will exceed the preliminary estimates and some very largely.

In order to arrive at an intelligent understanding of the probable cost of the entire improvement of the Middle Division of the Erie, and the Oswego canal, I have prepared the following condensed statement.

ERIE CANAL.

Engineer's estimate of work under contract......	$2,537,571 50
Not under contract	12,425 00
	$2,549,996 50
Add 10 per cent. for contingencies	254,999 50
Total	$2,804,996 00

OSWEGO CANAL.

Engineer's estimate of work under contract.....	$ 241,592 00
Not under contract	1,205,115 00
	$1,446,707 00
Add 10 per cent. for contingencies	144,670 00
Total	$1,591,377 00
Grand total	$4,396,373 00

The following tables have been computed as required by law, covering all the work on the Middle Division during the last fiscal year, ordinary and extraordinary repairs as well as on the account of the improvement under chapter 79, Laws of 1895, and subsequent acts in relation thereto:

TABLE No. 1.

This table shows the names of engineers duly appointed by the State Engineer and Surveyor, time employed, rate of compensation, and the amount paid during the year with the amount of other miscellaneous expenditures by the Divison Engineer.

TABLE No. 2.

This table covers the contracts in force at the close of the fiscal year, together with the engineer's estimate, estimate at contract prices, and amount paid on each contract.

TABLE No. 3.

This table covers the contracts completed and settled during the fiscal year, with engineer's estimate and total cost of each piece of work as returned in final account.

TABLE No. 4.

This table covers the work not under contract to complete the improvement of the Middle Division of the Erie and the Oswego canal, with the engineer's estimate of the cost thereof.

TABLE No. 5.

This table exhibits water record of Cayuga and Cross lakes and Seneca river, taken triannually since 1884, in pursuance of concurrent resolutions of the Senate and Assembly, passed in 1884.

These water records are taken three times each year at quite an expense each time, and I beg to again call your attention to the fact that it is believed that these records are required to be taken at certain fixed time without regard to the stage of water, and unfortunately the time is not the time of either low or high stage of water in the river. Perhaps the thirteen years that these

levels have been taken shows all that would be proven by their continuance, but if it is desired to show the fall in the river at the several points named at the extreme stages of the water, discretion as to time when the levels are to be taken should be given to this Department as the best judges when those stages are reached, which varies considerably each year.

In order that the extent of reduction of the quantities made in the preliminary estimates before letting the work may be seen, the following comparative table is prepared, showing first original estimate and second revised estimate for the several contracts covering the entire length of Middle Division of the Erie canal, not including structures.

No. of contract.	Original estimate.	Revised estimate.
1	$208,420 00	$136,468 00
2	239,772 00	185,078 30
3	142,978 55	127,780 50
4	155,409 65	138,931 50
5	161,618 05	141,444 50
18 and 19	325,208 70	202,695 50
20 and 21	584,243 55	464,900 00
22 and 23	509,071 20	413,362 00
24 and 25	394,884 00	282,731 00
26, 27 and 28	476,775 75	443,751 00
	$3,198.381 45	$2,537,142 30

The division engineer has endeavored to keep the State Engineer and Surveyor fully advised of all the conditions relating to the work on the middle division, and he knows of no instance of variance between himself and his superior officers.

Photographs showing the work in its various stages at different points are herewith submitted.

Very respectfully submitted,

W. H. H. GERE,

Division Engineer.

SYRACUSE, N. Y., *December* 24, 1897.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor, Albany, N. Y.:*

Sir.— Herewith I have the honor to submit my annual report covering work performed by the engineering department on the middle division for the fiscal year ending, September 30, 1897— on account of ordinary and extraordinary repairs.

As has always been the case, the engineer department is required to supply the Superintendent of Public Works Department with plans, bills of material and estimates of cost for much of the work of ordinary repairing performed by section superintendents.

The regulations require the division or resident engineer "to be at any break in the canal immediately after it occurs and remain there till completion of repairs and water up to full height." In compliance with this rule the following breaks have come under the observation and careful attention of this department, the repairs of which were made by the Superintendent of Public Works:

First. Immediately on the opening of Black River canal, a small break occurred in the towing-path near the head of lock No. 96 which was, no doubt, caused by boatmen closing paddles in lock gates which were left open during the night as a precau-

tionary measure until the sluice around the lock (which had been built during the winter) was completed. No lock tender being employed nights, the conditions were not understood by boatmen. The break was repaired, delaying navigation a short time.

Second. On June 6th, a break occurred in a composite culvert just below lock at Montezuma on Cayuga and Seneca canal. This culvert was built many years ago and like most culverts built at that time, was defective in plan, in that the floor planking was laid lengthwise of the culvert with no binding to secure them, and when the spiking became rusted off, the plank floated, leaving a free course for the water in the canal prism into the culvert. This same condition was experienced last year at culvert No. 80, Erie canal. The break was promptly repaired temporarily, delaying navigation about four days. This culvert will be rebuilt the coming winter by substituting cast iron pipe in place of the wooden trunk. In this connection, I advise that all the old culverts be carefully examined and floor secured before being displaced, and a consequent break to repair, liable to cost more to repair than to secure the floors of all the culverts on the division.

Third. July 23d, a break occurred in lock No. 48, Erie canal, the repair of which delayed navigation one week. This was an ugly break to repair as the foundation at the head of double lock had become undermined, allowing a free passage of water from one lock to the other. The foundation timbers had settled out of place and allowed the masonry also to settle. The platform and tumble gates were broken down and had to be renewed. By diligent effort on the part of the superintendent, night and day, the repairs were completed and navigation resumed in less time than at first seemed possible. This lock should have careful and, probably extensive, repairs during the winter.

Fourth. On July 23d, a break also occurred in the towing-path of Forestport feeder about one mile from Forestport. This was the most extensive and disastrous break that has occurred for many years. The bank was of sand some 70 feet high, and when 11 miles had discharged itself through the break, the opening was something fearful, being 400 feet long on top and 50 feet deep. Forces were organized at once by the Superintendent of Public Works and work was continued night and day for 30 days, when water was let into the feeder soon after navigation was reopened. Leaks from percolation were discovered and after a few days it became evident that the foot of the bank must be protected with brush and stone or the bank would again be carried away. The water was again drawn from the feeder and toe of the bank protected to prevent sloughing of the back slope, and after three days the level was again filled. Since that time there has been no trouble experienced. During the time water was out of the feeder, the Black River canal was closed for want of water and the Erie canal supply from the reservoirs was completely shut off. Fortunately there was a good supply in the Madison county reservoirs which enabled navigation to be maintained during time of repairs of feeder at Forestport. In order that the canal at that place may be made safe beyond a contingency, much further work should be done, filling the bottom of the canal prism and loading and protecting the rear slope of the bank.

Upon the line of the Erie canal where work was done under improvement contracts, leaks of a dangerous character have been discovered and necessary repairs made in time to prevent interruption of navigation. This condition will very likely arise after the silt is removed from the prism, which will require close watching and prompt attention as soon as discovered.

The following is a statement covering work done during the fiscal year, under contract, in pursuance of special laws:

WORK COMPLETED AND SETTLED.

IRON SUPERSTRUCTURE OVER BLACK RIVER CANAL AT CARTHAGE.

(Act, Chapter 102, Laws of 1895.)

Dated July 2, 1896, Buffalo Bridge and Iron Works, contractors.

Engineer's estimate	$18,921 00
Final account	15,170 00

ALTERATIONS AND REPAIRS TO PIERS AND ABUTMENTS TO CARTHAGE BRIDGE.

(Act, Chapter 102, Laws of 1895.)

Dated June 29, 1896, Dunfee, Belden, Dwyer & Co., contractors.

Engineer's estimate	$5,135 00
Final account	5,403 15
Appropriation, both contracts	25,000 00

This bridge is of steel, plate girder, 454 feet in length of spans; roadway, 20 feet wide, with sidewalk upon one side, taking the place of an old bridge which had been unsafe for several years. Since the completion of the bridge, the people of Carthage desire the west end of the bridge raised three feet, which the Superintendent will be enabled to do from unexpended balance of appropriation.

IMPROVING CAYUGA AND SENECA CANAL AND OUTLET OF SENECA LAKE.

(Act, Chapter 308, Laws of 1895.)

Dated October 1, 1895, E. H. Fleming & Co., contractors.

Engineer's estimate	$13,600 00
Final account	10,937 72
Appropriation	20,000 00

The work done under this contract consists of timber docking on pile foundation on berme side of canal between Geneva and the outlet, and constructing stone piers and breakwater at the outlet. A portion of the appropriation was expended by the Superintendent repairing docking in canal near the harbor at Geneva.

DISCHARGE PIPES AT NORTH BRANCH RESERVOIR.

(Act, Chapter 148, Laws of 1895.)

Dated August 29, 1895, J. H. Nelson, contractor.

Engineer's estimate	$17,983 00
Final account	17,316 05
Appropriation	25,000 00

The work done under this contract consisted of removing a portion of the wood discharge trunk and substituting cast-iron pipes. The old trunk was so badly decayed below the slide gates that it was deemed unsafe to trust it longer. The present arrangement is durable and safe, and fully meets every condition required. From this appropriation of $25,000, $5,240.38 was paid to Michael Bennett last year for constructing road over spillway at North Branch reservoir.

CONTINUING CONSTRUCTION OF BRIDGE AND APPROACHES OVER INLET TO OTISCO LAKE.

(Act, Chapter 793, Laws of 1896.)

Dated September 4, 1896, Hughes Bros., contractors.

Engineer's estimate	$8,912 00
Final account	9,782 81
Appropriation	10,000 00

The work done under this contract consisted in building and protecting an embankment across the low land at the head of Otisco lake, which is flooded about 8 feet when the lake is full. The bank is now two-thirds across the low ground, and is of no use as a highway until the remaining portion is built. A further appropriation of $10,000 will complete the work and furnish a highway of which the people have been deprived since the lake was appropriated for a canal reservoir

REPAIRING CULVERT UNDER OSWEGO CANAL, BETWEEN HYDRAULIC CANAL AND OLD SKENANDOAH MILLS, AT OSWEGO.

(Act, Chapter 947, Laws of 1896.)

Dated December 2, 1896, E. S. Candee, contractor.

Engineer's estimate	$3,896 00
Final account	8,654 75

When a break occurred at this culvert last year a temporary dam allowed navigation to be maintained. The estimate was based upon a supposition that only the head of the culvert would need repairing, but when water was drawn from both the canal and the hydraulic canal it was discovered that the whole structure would require rebuilding before the improvement of the Oswego canal at that point could safely be made, which was done. This accounts for large increase of cost over estimate prior to letting the work. Since the completion of this contract it has been discovered that the original culvert was built by private parties under a permit from the Canal Commissioners in 1866, for the purpose of supplying power to the mill on west side of the canal and should have been rebuilt by the owner of the power or abandoned outright.

SUPERSTRUCTURE FOR LIFT BRIDGE AT WEST GENESEE STREET, SYRACUSE.

(Act, Chapter 311, Laws of 1895. Act, Chapter 950, Laws of 1896.)

Dated July 3, 1896, Hilton Bridge Construction Co., contractors.

Final account	$10,221 40

SUBSTRUCTURE FOR LIFT BRIDGE AT WEST GENESEE STREET, SYRACUSE.

(Act, Chapter 311, Laws of 1895. Act, Chapter 950, Laws of 1896.)

Dated July 1, 1896. Brumelkamp & Lane, contractors.

Engineer's estimate for both contracts	$14,923 25
Final account	10,129 39
Appropriation for entire bridge	22,500 00
Of which the city of Syracuse paid	10,000 00

This bridge is upon an entirely new plan, designed by George P. Hilton, of Albany, intended to overcome obstacles that prevented the use of style successfully used at Clinton and Geddes streets in this city.

The culvert extending across the canal between the counterweight pits is upon gypsum foundation, with a course of concrete 12 inches thick, upon which the culvert of 6-foot chord was erected in a substantial manner. During the early spring, before opening of navigation, the city authorities constructed a 4-foot sewer, with bottom about 4 feet below the culvert, using explosives to loosen the rock; also the water and gas companies relaid their mains across the canal prism, the result of which was to so shatter the rock that within a few days after the canal was filled, water

found its way into the bridge culvert, under a head of 16 feet, to such an extent as to completely prevent the operation of the bridge. An effort was made to stop the leaks by a carpet of hop sacking and covering with clay, but without accomplishing the desired result, and the bridge has been suspended all the season. After the close of navgation heroic efforts will be made to put the structure in working order before the opening of navigation next spring.

STEEL TRUNK FOR SAQUOIT CREEK AQUEDUCT.

(Act, Chapter 947, Laws of 1896.)

Dated December 12, 1896, Hilton Bridge Construction Co., contractors.

Engineer's estimate	$7,080 00
Final account	8,227 57

The old wooden trunk was removed and new steel structure inserted in its place, making a much more permanent arrangement. The new trunk will carry 9 feet of water, as required for the improvement of the Erie canal. As the old trunks fail they should be rebuilt of steel in all cases.

REBUILDING CULVERT NO. 80, ERIE CANAL.

(Act, Chapter 947, Laws of 1896.)

Dated December 12, 1896, Daniel Baldwin, contractor.

Engineer's estimate............................	$2,098 00
Final account	2,437 82

This culvert failed during the season of navigation last year and was closed up to maintain navigation. Proper repairs were made which will make the structure safe for several years.

IMPROVING BLOODY BROOK AND CONSTRUCTING A CAST IRON PIPE CULVERT ACROSS OSWEGO CANAL AT BLOODY BROOK.

(Act, Chapter 947, Laws of 1896.)

Dated December 11, 1896, E. B. Baker, contractor.

Engineer's estimate	$13,855 25
Final account	14,381 74

Great trouble has been experienced for years at this culvert from filling up with earth, stopping the flow of water and flooding a large amount of land, creating claims for damages each year. Two years ago a break occurred at this culvert just before opening of navigation. Temporary repairs were made at a large expense. A new culvert has been built consisting of five lines of 48-inch cast iron pipe and the channel opened above and below the culvert of sufficient capacity to carry the stream at all times.

STEEL SWING BRIDGE NEAR LOWVILLE, KNOWN AS ILLINGSWORTH BRIDGE OVER BLACK RIVER.

(Act, Chapter 947, Laws of 1896.)

Dated December 5, 1896, Oswego Bridge Co., contractors.

Engineer's estimate	$2,727 50
Final account	3,002 78

The old wooden swing bridge was replaced with a modern steel structure.

REBUILDING LOCK NO. 49, BLACK RIVER CANAL.

(Act, Chapter 1030, Laws of 1895; Act, Chapter 947, Laws of 1896.)

Dated December 9, 1896, Wm. J. Cramond, contractor.

Engineer's estimate	$16,744 00
Final account	16,899 19

This lock was selected as the one first requiring rebuilding, but all the original locks south of the summit are in a terrible condition and must be rebuilt very soon as any of them may collapse at any time. The plan adopted furnishes a structure equal to the Erie canal locks of the best gray limestone dressed and laid in the most perfect and substantial manner.

REBUILDING LOCK NO. 96, BLACK RIVER CANAL.

(Act, Chapter 1030, Laws of 1895; Act, Chapter 947, Laws of 1896.)

Dated December 30, 1896, Dodge & McGregor, contractors.

Engineer's estimate	$14,233 50
Final account	19,521 93

This lock was supposed to be one of the best of the original construction, but just before the close of navigation it completely failed from undermining, allowing the walls to settle and completely destroying its usefulness beyond all hopes of repair short of rebuilding. Plans and estimate were hurriedly prepared and the work put under contract at the earliest possible time.

When the walls were removed the foundation was found to be upon quicksand of the worst possible kind. To procure and drive piles was out of the question for lack of time before opening of navigation. The plan of making a solid foundation of plank on edge was adopted, casting aside the old timbers and surrounding the whole foundation with triple-lap sheet piling 16 feet long, thereby enclosing the quicksand as in a box, which was less expensive than piles and equally as effective. The lock was completed in the least time possible, delaying the opening of navigation but a few days. Owing to conditions which could not have been anticipated in advance, the final account exceeded the preliminary estimate by about $5,300, but its stability fully justified the extra cost.

REBUILDING BRIDGE OVER BLACK RIVER, AT GLENDALE.

(Act, Chapter 800, Laws of 1896, and Chapter 790, Laws of 1897.)

Dated March 17, 1897, Hilton Bridge Construction Co., contractors.

Engineer's estimate	$6,001 50
Final account	6,857 35

Appropriations.

Chapter 800, Laws of 1896	$7,000 00
Chapter 790, Laws of 1897	1,000 00

This structure consists of two fixed spans and one swing, built of steel in the most substantial manner. This Department not being aware of the additional appropriation under chapter 790, Laws of 1897, omitted to have work done on piers that should have been performed in order to keep within the appropriation of $7,000, but as there is sufficient funds available, the work necessary for the safety of the bridge should yet be done by the Superintendent of Public Works and paid for from the appropriation under chapter 790, Laws of 1897.

Work not Completed.

REPAIRS TO BREAKWATER, PIERS, DAM NO. 1 AND GATES; ALSO REMOVING BARS AT OWASCO LAKE OUTLET.

(Act, Chapter 799, Laws of 1896.)

Dated December 8, 1896, J. J. Hallock, contractor.

Engineer's estimate	$8,624 00
Payments to September 30th	6,137 00
Appropriation	10,000 00

The work under this contract has progressed slowly, being somewhat delayed by high water in the lake, but it will be finished before the close of this season. This lake is used as a reservoir to feed the Erie canal, entering at Port Byron. The channel from lake to dam No. 1 has been deepened and enlarged to permit a greater flow as necessity requires.

CONSTRUCTING RUBBLE MASONRY WALLS AT FOOT OF OWASCO LAKE.

(Act, Chapter 799, Laws of 1896; Act, Chapter 561, Laws of 1897.)

Dated, September 1, 1897. J. J. Hallock, contractor.

Engineer's estimate	$16,509 00
Payments to September 30th	2,550 00
Appropriation	18,000 00

This work consists of a stone pier or breakwater extending into the lake about 1,240 feet; also constructing a sea wall for a distance of about 1,185 feet along the highway at the foot of the lake. This work is now in progress and will probably be finished before winter.

REBUILDING EAST PIER AT BELGIUM BRIDGE, OSWEGO CANAL.

(Act, Chapter 950, Laws of 1896.)

Dated, December 7, 1896. J. J. Hallock, contractor.

Engineer's estimate	$2,570 00
Payments to September 30th	2,125 00
Appropriation	3,000 00

This work consists of rebuilding the east pier under the present iron bridges. As this bridge extends across the Oswego river as well as the canal, the towns of Clay and Lysander, bordering upon the river, pay one-half the cost of this pier. The work is substantially completed and final account will be rendered as soon as coffer-dam is properly removed.

PROTECTING CAYUGA AND SENECA CANAL AT GENEVA.

(Act, Chapter 142, Laws of 1895.)

Dated, August 6, 1895. E. H. Fleming and Company, contractors.

Engineer's estimate	$15,000 00
Payments to September 30th	9,979 00
Appropriation	15,000 00

This work consists of extending and completing a sea wall along the north shore of Seneca lake. The work has been prosecuted so slowly that the cost of engineering is much out of proportion to the cost of the work. While every effort was made by this department to have more vigor displayed in its prosecution, it was not deemed advisable to certify to the abandonment of the contract. However the work is now substantially completed and final account will be returned at an early date. The local authorities agreed to fill the embankment in rear of the work when the wall had been built. This they have done only to a small extent near Geneva. The whole length should be filled for the stability of the work and benefit of the highway in rear of the wall.

CHANGING AND RECONSTRUCTING GENESEE STREET BRIDGE AT UTICA.

(Act, Chapter 170, Laws of 1895; Act, Chapter 950, Laws of 1896.)

Dated, July 31, 1896. Havana Bridge Works, contractors.

Engineer's estimate		$28,637 15
Payments to September 30th		21,964 00
Appropriation by State	$25,000 00	
Appropriation by city of Utica	8,000 00	
		33,000 00

This work consisted of the removal of the fixed bridge and constructing a new one of single roadway, moving hoist bridges six feet towards center of the street and erecting two overhead foot bridges, together with the reconstruction of substructure and rearrangement of hoisting power and machinery. Since the opening of navigation this bridge has been in operation and gives general satisfaction. Final account will soon be rendered.

REBUILDING LOCKS Nos. 51 AND 55, BLACK RIVER CANAL.

(Act, Chapter 566, Laws of 1897.)

Dated, September 1, 1897. Wilkes D. Dodge, contractor.

Estimated cost each lock	$15,785 00
Payments to September 30th, lock 51	1,207 00

These locks are to be rebuilt of cut stone upon plan in use for four years. The locks in worst condition are selected for rebuilding. At least 6 locks should be rebuilt each year as at that rate it will require 10 years to rebuild those that are liable to fail at any time. One hundred thousand dollars should be set apart each year for rebuilding these locks if the Black River canal is to be maintained.

SUPERSTRUCTURE FOR SWING BRIDGE AT GARDEN STREET, ROME.

(Act, Chapter 965, Laws of 1895.)

Dated, April 16, 1896. Havana Bridge Works, contractors.

Engineer's estimate	$4,000 00
Payments to September 30th	2,635 00
Appropriation for entire bridge	7,000 00

This bridge is completed and in operation. Final account will be rendered soon.

The foregoing comprises all of the extraordinary repairs that have come under the supervision of this department for the past year. It has been our effort to have all work done in the most substantial manner and it is believed the character of work done fully justifies the effort.

In closing this report I beg leave to state that the organization of this department for the improvement, made up as it was on short notice of large number of men of satisfactory educational abilities, but deficient to a large extent in experience in construction, has been attended with some embarrassment, but I bear willing testimony to their honest endeavor to do their full duty, and to their courteous bearing toward their superior officers.

Very respectfully submitted,

W. H. H. GERE,

Division Engineer.

Western Division.

Hon. Campbell W. Adams, *State Engineer and Surveyor:*

Sir.—I have the honor of submitting to you my report on the Western Division of the State Canals for the fiscal year ending September 30, 1897.

The canal, slips and navigable feeders are as follows:

	Miles.
Erie canal from the east line of Wayne county to Hamburg street in the city of Buffalo	148.92
Five slips in the city of Buffalo, aggregate length	1.60
Genesee river feeder, in the city of Rochester	2.25
Total	152.77

UNNAVIGABLE FEEDERS.

Tonawanda and Oak Orchard	11.55
Genesee Valley canal, from Cuba reservoir to lock No. 87, Rockville	7.65
Genesee Valley canal, from Scottsville to Rochester Rapids dam	11.00
Total	30.20

The resources of water supply for the Erie canal are as follows:

1. Lake Erie, at Buffalo.
2. Tonawanda creek, at Pendleton.
3. Tonawanda and Oak Orchard creek, at Medina.

4. Allen's Creek through the Genesee Valley canal and Genesee river feeder, from Scottsville to Rochester; this water is connected from the Genesee Valley canal by pipe, across the Genesee river to the feeder below the Rapids dam and thence into the canal.

5. The Cuba reservoir in Allegany county, through the Genesee Valley canal and the Genesee river to Rochester, and through the Genesee river feeder in the city of Rochester into the canal. The Tonawanda and Oak Orchard feeder and the Genesee river assist in filling the canal in the spring; the water from Allen's creek at Scottsville, which is taken into the feeder at Rochester, tends to keep the water in the feeder pure during the summer months.

DAMS.

There are six dams on the division as follows:

1. One across Tonawanda creek near its mouth; it raises the waters in the creek about four feet above the level of the Niagara river.

2. One across the same creek south of Medina; its purpose is to turn the waters of the creek into the feeder and through it into the channel of Oak Orchard creek, and thence into the canal at Medina.

3. One across Allen's Creek, in the village of Scottsville, to send the water through the Genesee Valley canal, which is now used as a feeder from Scottsville to Rochester.

4. One across the Genesee river at Rochester to turn the water of the stream into the feeder.

5. One across Oak creek, near the village of Cuba, Allegany county, to hold the waters of that creek and form a reservoir; it is composed of earth faced with rip-rap and slope wall, and

is 2,200 feet long and 65 feet in height where it crosses the stream.

6. One across a valley two miles from the last mentioned one; it has a waste-weir composed of stone to serve as an escape for the waters of the creek when the reservoir is full.

LOCKS.

There are twenty-three locks on this division and all lock down toward tide-water.

No.	Location	Lift in feet.
53.	One and one-fourth miles west of Clyde (lengthened),	4.755
54.	At lock Berlin (lengthened)......................	7.360
55.	In the village of Lyons (lengthened).............	6.251
56.	Poorhouse; one and seven-tenths miles west of Lyons (lengthened)..................................	9.848
57.	Lower lock at Lockville, near Newark (not lengthened)..	8.028
58.	Middle lock at Lockville, near Newark (not lengthened)..	8.004
59.	Upper lock at Lockville, near Newark (not lengthened)..	8.002
60.	Eight-tenths of a mile east of Macedon (lengthened),	9.886
61.	In the village of Macedon (lengthened)...........	6.601
62.	Two and one-quarter miles west of Pittsford (lengthened)..................................	8.807
63.	Miller's lock in the village of Brighton (lengthened),	8.719
64.	Sipple's lock in the village of Brighton (lengthened),	10.108
65.	Reservoir lock in the city of Rochester (lengthened),	10.102
66.	First lock in the city of Rochester (lengthened).....	8.859

No.	Location.	Lift in feet.
67-71.	Five combined locks at Lockport (not lengthened),	57.427
	One guard lock at Sulpher Springs (deepened); it has one chamber, 110 x 20 feet and two additional head-gates. These gates are closed when a flood occurs in Tonawanda creek; otherwise, they are left open.	
	One river lock at Tonawanda connecting the Niagara river with the canal; the lift is generally four feet, depending on the height of water in the river.	
	One double chamber guard and lift lock (lengthened and deepened) at Black Rock (No. 72); it is 112 x 20 feet. The lift, together with the fall in the harbor from the canal below the mean low water in the lake is	2.425
	Total	175.182

By adding to the above lifts the surface descent on the different levels, we get the total descent on the division:

On Montezuma level	.196	
On Twelve-mile level, Nos. 59 to 60	.165	
On Seventeen-mile level, Nos. 61 to 62	.343	
On Three-mile level, Nos. 62 to 63	.063	
On long level, Rochester to Lockport, Nos. 66 to 67	3.165	
On level between Lockport and Black Rock	1.239	
		5.171
Total descent going west		180.353

There is also one single chamber ship lock from Black Rock harbor to Niagara river; it is 200 x 36 feet. The lift is usually four feet, depending on the height of water in lake and river. The weigh lock, in the city of Rochester, has not been used as such for some years.

Nearly all the locks on this division, with the exception of the Black Rock and Sulphur Spring guard locks, need repairing; but this work is to be done under the canal improvement in connection with the deepening of the locks, as will be noted later

BRIDGES.

Over the Erie canal and slips connecting there are 274 bridges, of which 37 are built of wood, 21 of wood and iron and 216 of iron or steel, 37 of the last being railway bridges. All the wooden bridges, with the exception of a few recently renewed are in bad repair and should be replaced soon by steel or iron structures.

During the year the following bridges were built; the cost of those built by contract, together with other details, can be found in the tables annexed.

Jersey street, Buffalo, act, chapter 668, Laws of 1894, and act, chapter 482, Laws of 1896.

A bridge that had been in use at Porter avenue, Buffalo, was repaired, widened and placed upon the abutments at Jersey street, which were built under act, chapter 668, Laws of 1894.

Porter avenue, Buffalo, N. Y., act, chapter 590, Laws of 1895, and act, chapter 482, Laws of 1896.

The money used in building this bridge was furnished, in part, by the State and in part by the city of Buffalo. Porter avenue, where it crosses the Erie canal, is a part of the Park system of Buffalo, and a bridge larger and more artistic than would otherwise have been built was deemed necessary.

The bridge as built is a riveted steel arch of 186 feet span between pin centers and a 15-foot rise of arch. It has one roadway 50 feet wide and two sidewalks each 25 feet wide. The roadway is paved with asphalt and the sidewalk with concrete topped with crushed granite laid in 5-foot squares, both pavement and sidewalks being guaranteed for five years. Cast-iron ornamental work is applied to the two outside girders, the design consisting of pilasters with intervening panels, capitals surmounting the pilasters and a projecting cornice at the level of the sidewalk. A cast-iron balustrade with panels supporting ornamental posts carrying a pipe railing, extends along each side of the bridge and terminates in the masonry buttresses at each end. These buttresses support the electrolier posts, each of the four posts carrying three clusters of three 50-candle power incandescent electric lights each. A large globe of opalescent glass set in a wrought iron basket encloses each cluster of lights.

The abutments of the bridge are founded on piles and are built of concrete faced with rock pointed limestone. The wings curved and coped with bush hammered limestone. The ends of the wings are topped by bush hammered limestone balls, four feet in diameter. A circular buttress of bush hammered limestone is on each end of the abutments. The bridge, as completed, presents a fine appearance, and, up to date, there has been no sign of settlement.

The other bridge work done during the year contained no items of especial interest, the laws governing the same and the tables annexed showing the character and cost of the work. Most of the bridges in Buffalo, excepting those built within the last few years, are altogether too light for the traffic which they are now carrying. A number of applications from street rail-

ways, desiring to lay tracks across different bridges, and from companies desiring to move extra heavy loads have had to be denied on account of the condition of the bridges. Genesee street and Commercial street bridges across the Erie canal, and Perry street and Elk street bridges across the Clark and Skinner canal, and Washington street bridge across the Hamburg canal are especially unsafe. The last has been strengthened this year by piling.

In Rochester the West avenue lift bridge and the Exchange street swing bridge are unsafe. A bill for a new bridge at Exchange street has been passed, but the money appropriated is not large enough to build such a bridge as the bill calls for. Plans, specifications and estimates for this bridge have been sent to this office.

I should also recommend that in future all highway and farm bridges now built of wood should, as occasion requires, be replaced by iron or steel structures; and also that more attention should be paid to the painting of all steel and iron structures belonging to the State. Most of the metal structures are deterio rating much more rapidly than is usual, because of lack of paint.

GENERAL.

All of the other work done on this division during the past year has been in the line of repairs, and the laws and tables "Contracts completed" and "Contracts pending" will give a general idea of the work. On the line of the Erie canal most of the repairs needed are already under control or are planned for, as will be noted later. A large amount of work is necessary in the Indian reservations. The roads and most of the bridges except those repaired during the last two years, are in very poor con-

dition. I should recommend an appropriation of at least $25,000 to be expended during the next summer on the reservations.

The Tonawanda dam and the Tonawanda River lock should be remodeled, as recommended in last year's report. The high towpath canal bank, about four miles west of Rochester is, and has been for a number of years, in an unsafe condition, and should be made safe, probably by a change in the location of the canal. Plans contemplating both of these last improvements are now being made.

No breaks causing any great delay to navigation have occurred. Culvert No. 1, which was repaired last winter, caused some trouble in the early spring. This will be repaired during the coming winter.

Besides the work done showing in tables, "Contracts Completed" and "Contracts pending," the following work done by the State forces has been planned and supervised by this department:

Act, chapter 974, Laws of 1896, appropriation $570, for building a pile dock in Tonawanda creek.

Act, chapter 947, Laws of 1896, appropriation $8,000, for building a temporary coffer-dam and aqueduct at Lockport.

Act, chapter 790, Laws of 1897, appropriation $800, for repairing and graveling highway across Cattaraugus Indian Reservation from Lawton station to Thomas asylum.

Act, chapter 950, Laws of 1896, and act, chapter 790, Laws of 1897, appropriation $2,000, for building a bridge and improving State roads in the Tonawanda Indian Reservation.

Act, chapter 790, Laws of 1897, appropriation $1,000, for removing obstructions in Findlay's lake.

Act, chapter 790, Laws of 1897, appropriation $3,000, for repairing and preserving highways in the Allegany Indian Reservation.

Act, chapter 790, Laws of 1897, appropriation $1,000, for repairing and preserving highways in the Cattaraugus Indian Reservation.

Act, chapter 790, Laws of 1897, appropriation $6,000, for constructing a bridge over the Allegany river between Carrolton and Allegany, Cattaraugus county.

Act, chapter 947, Laws of 1897, appropriation $4,840, for improving the channel from the State culvert, under the Erie canal, at Brockport.

Act, chapter 791, Laws of 1897, appropriation $300, for repairing abutments and filling washout at Clear Creek bridge, Cattaraugus Indian Reservation.

CANAL IMPROVEMENT WORK.

Act, chapter 79, Laws of 1895; act, chapter 794, Laws of 1896; act, chapter 43, Laws of 1897; act, chapter 569, Laws of 1897, appropriation, $9,000,000.

As reported in last year's report, the surveys for the work was finished during the year ending September 30, 1896. Plans for the entire improvement with the exception of (1) the lowering of the Rochester aqueduct, (2) the rebuilding five stop-gates, and (3) the improvement and lowering of locks 57, 58 and 59, have been submitted to you during the past year.

The exact manner of doing the work under the three exceptions noted above has not been determined. Table No. 3, annexed, shows the length, engineer's estimate, and, as far as let, the contract price for all of this work.

A statement of the engineering expenses is annexed showing in detail the names of the persons employed, time of service and compensation of each. The division, during the past year, has been in charge of J. L. Little as division engineer, C. R. Neher as resident engineer, and M. W. Wilbur as first assistant engineer.

Respectfully submitted,

J. L. LITTLE,

Division Engineer.

WESTERN DIVISION, ERIE CANAL.

(No. 1.)

Table of Contracts finished during the year ending September 30, 1897.

CONTRACTOR.	Contract signed.	Work finished.	Character of work.	Legislative Act. Chap.	Legislative Act. Laws.	Appropriation.	Engineer's estimate.	Contract price.	Final estimate.
Logie & Leh	Dec. 26, 1894	Nov. 11, 1896	Moving Porter ave. bridge to Jersey st., Buffalo, N. Y.	668 469	1894 1896	$10,000 00	$1,009 00	$946 25	$2,658 25
Buffalo Dredging Co.	May 8, 1896	May 29, 1897	Substructure for Porter ave. bridge, Buffalo, N. Y.	590 483	1895 1896	69,500 00	25,556 25	19,497 76	26,129 14
Buffalo Brass & Iron Works	May 8, 1896	June 24, 1897	Superstructure for Porter ave. bridge, Buffalo, N. Y.	590 482	1895 1896		46,066 00	61,600 00	61,600 00
White & Coughlin	Feb. 21, 1896	Nov. 21, 1896	Bridge and abutments at Schuyler st., Havana	57	1895	5,000 00	4,912 50	3,973 00	4,306 95
Connelly Bros.	Sept. 21, 1896	Oct. 14, 1896	Buoys for Erie Basin, Buffalo	691	1896	416 00	350 00	232 50	232 50
R. E. Beardsley	Dec. 3, 1896	Feb. 11, 1897	river at Chemung	949	1896	5,000 00	4,226 80	3,177 10	4,226 80
Pulford, Clark & Tidd	Feb. 8, 1897	Aug. 26, 1897	river at Elmira	950	1896	10,000 00	8,565 00	6,397 00	8,769 78
R. E. Beardsley	Dec. 8, 1896	Aug. 20, 1897	...ls along Falls creek, Havana	797	1896	5,000 00	3,694 50	3,059 48	4,291 80
Dodge & McGregor	July 7, 1896	Sept. 24, 1896	Abutment for Scott st. bridge, Buffalo	947	1896		3,600 70	3,296 90	3,209 74
Chas. A. Gorman	Dec. 7, 1896	May 7, 1897		947	1896		5,023 20	4,723 60	7,252 40
B. P. Smith	Dec. 8, 1896	May 27, 1897	s.	947	1896		2,519 00	2,595 75	3,800 84
B. P. Smith	Dec. 8, 1896	Apr. 24, 1897	t,	947	1896		3,142 25	3,108 75	3,091 30
B. P. Smith	Dec. 8, 1896	Mar. 31, 1897		947	1896		3,290 20	2,087 60	1,931 08
B. P. Smith	Dec. 11, 1896	Apr. 21, 1897		947	1896		4,884 00	4,819 70	6,165 88
John Calnan	Dec. 12, 1896	Apr. 23, 1897		947	1896		2,836 00	2,657 25	3,294 88
Chambers & Casey	Feb. 19, 1897	Apr. 5, 1897		947	1896		3,334 00	3,490 75	2,466 66
Thos. H. Karr	Feb. 11, 1897	May 6, 1897		947	1896		3,616 25	4,010 00	4,700 31
E. L. Oliver	Mar. 15, 1897	June 1, 1897		947	1896		3,987 80	3,880 00	4,729 14
Chas. A. Lux	Mar. 15, 1897	May 6, 1897		947	1896		1,089 70	1,080 40	1,078 96
Chas. A. Lux	Apr. 2, 1897	May 6, 1897	Vertical wall near Montezuma st., Lyons	947	1896		1,439 66	1,414 70	1,453 73
Whitmore, Rauber & Vicinus	Nov. 5, 1896	Apr. 24, 1897	Contract No. 4 (Cartersville waste weir)	79 794	1895 1896		11,485 37	8,485 00	11,097 47

NOTE—$125,000 was appropriated, under Act, Chapter 947, Laws of 1896, for General Repairs.

STATEMENT giving names, rank, number of days and compensation of Engineers upon the repairs of the Western Division of the New York State Canals, with incidental expenses, during the fiscal year ending September 30, 1897.

Ordinary Repairs.

(Chapter 946, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
J. L. Little	Division engineer	1 mo.	$3,000 00 per year	$250 00	$158 54	$408 54
C. R. Neher	Resident engineer	8 mos.	2,400 00 per year	600 00	282 36	882 36
W. L. Curtis	Assistant engineer	30	5 00 per day	150 00	41 26	191 26
Geo. E. Greene	Assistant engineer	12	5 00 per day	60 00	7 38	67 38
C. T. Middlebrook, Jr	Assistant engineer	81	5 00 per day	405 00	53 01	458 01
D. D. Waldo	Leveler	243	4 50 per day	1,093 50	245 34	1,338 84
F. E. Holleran	Leveler	52	4 50 per day	234 00	1 76	235 76
Wm. Crennell, Jr	Leveler	7	4 50 per day	31 50	4 74	36 24
S. G. Heater	Leveler	24	4 50 per day	108 00	1 51	109 51
G. O. House	Leveler	55	4 50 per day	247 50	51 98	299 48
F. H. Crafts	Leveler	44	4 50 per day	198 00	8 77	206 77
H. G. McKelvey	Draughtsman	5	4 00 per day	20 00	....	20 00
C. A. Poole	Draughtsman	4	4 00 per day	16 00	....	16 00
F. W. Hamilton	Rodman	27	3 50 per day	94 50	....	94 50
J. B. Barrett	Rodman	322	3 50 per day	1,127 00	17 39	1,144 39
Irving Hawkins	Rodman	175	3 50 per day	612 50	37 57	650 07
Chas. E. Cleaver	Rodman	148	3 50 per day	518 00	....	518 00
Chas. G. Douw	Rodman	77	3 50 per day	276 50	....	276 50
R. T. Webster	Chainman	50	3 50 per day	175 00	17 81	192 81
Henry Geck	Chainman	313	2 50 per day	782 50	10 68	793 18
Clinton J. Beam	Chainman	13	2 50 per day	32 50	8 55	41 05
James S. Cook	Chainman	14	2 50 per day	35 00	15 98	50 98
F. Mauerman	Chainman	14	2 50 per day	35 00	....	35 60
Chas. E. Whitcher	Chainman	78	2 50 per day	195 00	14 60	209 60
W. F. Hurley	Chainman	7	2 50 per day	17 50	6 56	24 06
						$8,350 94
Incidental expenses.						
Rent						550 29
Livery						171 75
Printing and stationery						708 88
Telegraph and telephone						75 50
Miscellaneous						228 58
						$10,085 94

Extraordinary Repairs — Porter Avenue Bridge, Buffalo.

(Chapter 590, Laws of 1895.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. T. Middlebrook, Jr.	Assistant engineer	158	$5 00 per day	$790 00	$63 93	$853 93
E. A. Sommer	Leveler	52	4 50 per day	234 00	....	234 00
Chas. G. Douw	Rodman	77	3 50 per day	269 50	1 50	271 00
Avery H. Wilcox	Chainman	27	2 50 per day	67 50	....	67 50
						$1,426 43
Incidental expenses.						
Stowell and Cunningham, inspection						690 80
Miscellaneous						58 00
Office rent						49 00
						$2,224 23

Extraordinary Repairs — Dredging Lower Black Rock Harbor.

(Chapter 320, Laws of 1895.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	25	$4 50 per day	$112 50	$13 42	$125 92
Chas. G. Douw	Rodman	52	3 50 per day	182 00	65	182 65
						$308 57

Extraordinary Repairs — Building Vertical Wall at Sodus Street, Clyde.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
S. Girard Heater	Leveler	9	$4 50 per day	$40 50	$5 53	$46 03
R T. Webster	Chainman	3	3 50 per day	10 50	5 42	15 92
						$61 95

Extraordinary Repairs — Rebuilding Vertical Wall at Montezuma Street, Lyons.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. T. Webster	Chainman	14	$3 50 per day	$49 00	....	$49 00
Chas. E. Whitcher	Chainman	35	2 50 per day	87 50	$3 03	90 53
						$139 53

Extraordinary Repairs—Enlarging Spillway, Cuba Reservoir.

(Chapter 950, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
M. W. Wilbur	First assistant engineer	3¾	$6 00 per day	$22 50	$10 88	$83 38
James W. Reed	Assistant engineer	4	5 00 per day	20 00	17 10	37 10
Irving Hawkins	Rodman	35	3 50 per day	122 50	7 02	129 52
						$200 00

Extraordinary Repairs — Rebuilding Vertical Wall Between S. Clinton and South St. Paul Streets, Rochester.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. H. Crafts	Leveler	49	$4 50 per day	$220 50	$6 30	$226 80
W. Crennell, Jr.	Leveler	17	4 50 per day	76 50	3 70	80 20
H D. Alexander	Leveler	15	4 50 per day	67 50	....	67 50
Geo. J. Lord	Leveler	2	4 50 per day	9 00	....	9 00
						$383 50

Extraordinary Repairs — Improving Channel of Falls Creek, Montour Falls.

(Chapter 797, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. P. Gillette	Assistant engineer	25	$5 00 per day	$125 00	$24 75	$149 75
F. H. Crafts	Leveler	40	4 50 per day	180 00	8 67	188 67
C. E. Whitcher	Chainman	12	2 50 per day	30 00	11 42	41 42
F. L. Hurlbut	Laborer	24	2 25 per day	54 00	5 82	59 82
L. Williams	Laborer	23	2 25 per day	51 75	8 59	60 34
						$500 00

Extraordinary Repairs — Dyke Along Chemung River at Chemung.

(Chapter 949, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	First assistant engineer	5	$6 00 per day	$30 00	$29 88	$59 88
H. P. Gillette	Assistant engineer	39	5 00 per day	195 00	39 45	234 45
F. L. Hurlbut	Laborer	35	2 25 per day	78 75	12 80	91 55
L. Williams	Laborer	35	2 25 per day	78 75	17 65	96 40
						$482 28
Incidental expenses.						
Rent						10 00
Miscellaneous						7 72
						$500 00

Extraordinary Repairs — Dredging and Removing Obstructions in Findlay's Lake.

(Chapter 950, Laws of 1896, and Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	5	$5 00 per day	$25 00	$34 44	$59 44
Chas. E. Whitcher	Chainman	27	2 50 per day	67 50	....	67 50
						$126 94

Extraordinary Repairs—Repairing Highways Cattaraugus Indian Reservation, from Lawtons to Versailles.

(Chapter 949, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. Mauerman	Chainman	11	$2 50 per day	$27 50	$4 83	$32 33

Extraordinary Repairs — Completing Bridge across Cattaraugus Creek at Versailles.

(Chapter 950, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
L. B. Fitch	Leveler	27	$4 50 per day	$121 50	$28 50	$150 00

Extraordinary Repairs — Repairs to Dock in Erie Basin.

(Chapter 489, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
R. T. Webster	Chainman	14	$3 50 per day	$49 00	....	$49 00
						$49 00
Incidental expenses.						
Labor						33 00
Boat hire						18 00
						$100 00

Extraordinary Repairs—Buoys in Erie Basin.

(Chapter 521, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	4	$4 50 per day	$18 00	....	$18 00
F. Mauerman	Chainman	2	2 50 per day	5 00	....	5 00
						$23 00

Extraordinary Repairs—Improving Channel of Newtown Creek.

(Chapter 949, Laws of 1896, and Chapter 791, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R Kaley	First assistant engineer	17	$6 00 per day	$102 00	$123 55	$225 55
H P Gilletie	Assistant engineer	164	5 00 per day	820 00	55 90	875 90
James Thomson	Rodman	52	3 50 per day	182 00	5 70	187 70
John O'Conner	Chainman	51	2 50 per day	127 50	3 90	131 40
Chas. E. Whitcher	Chainman	76	2 50 per day	190 00	3 70	193 70
F. L Hurlbut	Laborer	167	2 25 per day	375 75	30 17	405 92
L. Williams	Laborer	167	2 25 per day	375 75	46 80	422 55
						$2,442 72

Incidental expenses.

Office rent	25 00
	$2,467 72

Extraordinary Repairs—Exchange Street Bridge, Rochester.

(Chapter 514, Laws of 1896, and Chapters 572 and 591, Laws of 1897.)

George P. Hilton, plans	$75 00

Extraordinary Repairs — Building a bridge over Oak Orchard Creek Feeder, Medina.

(Chapter 791, Laws of 1896, and Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	8	$4.50 per day	$36 00	$35 55	$71 55

Extraordinary Repairs — Rebuilding Newark Waste Weir.

(Chapter 937, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Garrett O. House	Leveler	34	$4 50 per day	$153 00	$10 22	$163 22
R. T. Webster	Chainman	62	3 50 per day	217 00	4 20	221 20
						$384 42
Incidental expenses.						
Stowell and Cunningham, inspection						5 58
						$390 00

Extraordinary Repairs — Replacing two 24-inch pipes with one 48-inch pipe, under Erie Canal between 9th and 10th streets, Rochester.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George E. Greene	Assistant engineer	40	$5 00 per day	$200 00	$16 00	$216 00
William Crennell, Jr.	Leveler	21	4 50 per day	94 50	....	94 50
James S. Cook	Chainman	9	2 50 per day	22 50	....	22 50
						$333 00

Extraordinary Repairs — Dyke along the Chemung River, Elmira.

(Chapter 950, Laws of 1896 and Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	First assistant engineer	6	$6 00 per day	$36 00	$48 89	$84 89
H P Gillette	Assistant engineer	98	5 00 per day	490 00	30 95	520 95
Chas. E Whitcher	Chainman	10	2 50 per day	25 00	3 50	28 50
F. L. Hurlbut	Laborer	87	2.25 per day	195 75	3 70	199 45
L. Williams	Laborer	88	2.25 per day	198 00	60	198 60
W. A. Gillette	Laborer	14	2.25 per day	31 50	....	31 50
						$1,063 89
Incidental expenses.						
Office rent						25 00
						$1,088 89

Extraordinary Repairs — Building Bridge and Improving State Roads, Tonawanda Indian Reservation.

(Chapter 950, Laws of 1896 and Chapter 798, Laws of 1897.)

NAME.	[illegible]	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	13	$4 50 per day	$58 50	$23 55	$82 05
Chas. E. Cleaver	Rodman	26	3.50 per day	91 00	95	91 95
						$174 00
Incidental expenses.						
Livery						26 00
						$200 00

Extraordinary Repairs — Improving Channel Leading from State Culvert Under Erie Canal at Brockport.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D Waldo	Leveler	8	$4 50 per day	$36 00	$27 09	$68 09
Irving Hawkins	Rodman	26	3 50 per day	91 00	6 39	97 39
						$165 48

Extraordinary Repairs — Deepening and Improving Cayuga Creek.

(Chapter 559, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Geo. E. Greene	Assistant engineer	7	$5 00 per day	$35 00	$38 43	$73 43
Carl L. Lund	Leveler	6	4 50 per day	27 00	7 40	34 40
Geo. J Lord	Leveler	6	4 50 per day	27 00	11 19	38 19
W. F. Hurley	Chainman	6	2 50 per day	15 00	6 80	21 80
James S. Cook	Chainman	6	2 50 per day	15 00	10 39	25 39
						$193 21

Extraordinary Repairs — Deepening and Improving Mud Creek.

(Chapter 477, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. A. Van Alstyne	Assistant engineer	31	$5 00 per day	$155 00	$8 35	$163 35
Jas. W. Howe	Rodman	50	3 50 per day	175 00	2 25	177 25
						$340 60

Extraordinary Repairs.—Repairing and Preserving Highways on the Cattaraugus Indian Reservation.

(Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	3	$5 00 per day	$15 00	$11 46	$26 46
Casper Scholz	Leveler	2	4 50 per day	9 00	6 01	15 01
Jos. W. Howe	Rodman	2	3 50 per day	7 00	6 01	13 01
						$54 48

Extraordinary Repairs.—Constructing a Bridge over the Allegany River between Carrolton and Allegany.

(Chapter 790, Laws of 1897.)

NAME	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	8	$5 00 per day	$40 00	$35 96	$75 96
Casper Schols	Leveler	6	4 50 per day	27 00	14 98	41 98
Jos. W. Howe	Rodman	6	3 50 per day	21 00	14 98	35 98
Jos. Kiener	Laborer	6	2 25 per day	13 50	14 98	28 48
						$182 40

Extraordinary Repairs.—Genesee River Storage Dam.

(Chapter 950, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Geo W Rafter	Assistant engineer in charge	99	$10 00 per day	$990 00	$174 04	$1,164 04
W. Greenalch	Assistant engineer	119	5 00 per day	645 00	155 45	800 45
Wm. Crennell, Jr.	Leveler	13	4 50 per day	58 50	... .	58 50
R. W. Swanton	Chainman	13	2 50 per day	32 50	75	33 75
						$2,056 24
Incidental expenses.						
Labor						188 40
Stationery						6 00
Postage and telegraph						2 40
Office rent						50 00
Miscellaneous						295 25
						$2,598 29

Extraordinary Repairs—Repairing Abutments of Cook's Bridge and Lengthening Culverts 33 and 34, and Rebuilding Culvert No. 32, all in Pittsford, N. Y.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
James W. Reed	Assistant engineer	10	$5 00 per day	$50 00	....	$50 00
George E Greene	Assistant engineer	2	5 00 per day	10 00	$12 50	22 50
George J. Lord	Leveler	22	4 50 per day	99 00	....	99 00
James S. Cook	Chainman	19	2 50 per day	47 50	14 66	62 16
Clinton J. Bean	Chainman	10	2 50 per day	25 00	....	25 00
						$258 66

Extraordinary Repairs—Building Temporary Aqueduct and Coffer Dam at Lockport.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days	Rate of compensation.	Salary.	Travel.	Total.
H. A. Van Alstyne	Assistant engineer	10	$5 00 per day	$50 00	....	$50 00
E. R. Payne	Rodman	10	3 50 per day	35 00	....	35 00
A. W. Peters	Chainman	14	2 50 per day	35 00	....	35 00
						$120 00

Extraordinary Repairs — Rebuilding Iron Culvert Under Genesee River Feeder at Rochester.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George E. Greene	Assistant engineer	6	$5 00 per day	$30 00	....	$30 00
Wm. Crennell, Jr.	Leveler	7	4 50 per day	31 50	....	31 50
F. H Crafts	Leveler	33	4 50 per day	148 50	....	148 50
James S. Cook	Chainman	7	2 50 per day	17 50	....	17 50
						$227 50

Extraordinary Repairs — Rebuilding and Repairing Culverts Nos. 36 and 38 at Brighton.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Geo. E Greene	Assistant engineer	30	$5 00 per day	$150 00	$8 55	$158 55
Wm. Creunell, Jr	Leveler	26	4 50 per day	117 00	8 20	125 20
James S. Cook	Chainman	70	2 50 per day	175 00	23 95	198 95
						$482 70

Extraordinary Repairs — Rebuilding Iron Culvert Under Genesee River Feeder at Rochester.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George E. Greene	Assistant engineer	6	$5 00 per day	$30 00	....	$30 00
Wm. Crennell, Jr.	Leveler	7	4 50 per day	31 50	....	31 50
F. H Crafts	Leveler	33	4 50 per day	148 50	....	148 50
James S. Cook	Chainman	7	2 50 per day	17 50	....	17 50
						$227 50

Extraordinary Repairs — Rebuilding and Repairing Culverts Nos. 36 and 38 at Brighton.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Geo. E Greene	Assistant engineer	30	$5 00 per day	$150 00	$8 55	$158 55
Wm. Crennell, Jr	Leveler	26	4 50 per day	117 00	8 20	125 20
James S. Cook	Chainman	70	2 50 per day	175 00	23 95	198 95
						$482 70

Extraordinary Repairs — Rebuilding Culvert Between Medina and Knowlesville.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	26	$4 50 per day	$117 00	$16 05	$133 05
Chas. E. Cleaver	Rodman	81	3 50 per day	283 50	2 45	285 95
						$419 00
Incidental expenses.						
Livery						73 00
Rent						10 00
						$502 00

Extraordinary Repairs — Repairing Waste Weirs at Lockport, Middleport and near Mabee's Bridge.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days	Rate of compensation.	Salary.	Travel.	Total.
Irving Hawkins	Rodman	36	$3 50 per day	$126 00	$8 00	$134 00
Chas. E. Whitcher	Chainman	20	2 50 per day	50 00	1 20	51 20
						$185 20

Extraordinary Repairs — Removing Old Pile Dam Across Chemung River at Corning, Etc.

(Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. P. Gillette	Assistant engineer	5	$5 00 per day	$25 00	$4 05	$29 05
F. H. Crafts	Leveler	4	4 50 per day	18 00	2 75	20 75
Chas. E Whitcher	Chainman	4	2 50 per day	10 00	4 17	14 17
F. L Hrribut	Laborer	4	2 25 per day	9 00	3 96	12 96
L. Williams	Laborer	4	2 25 per day	9 00	2 90	11 90
						$88 83

Extraordinary Repairs — Repairing and Preserving Highways on the Allegany Indian Reservation.

(Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	6	$5 00 per day	$30 00	$27 77	$57 77
Casper Scholz	Leveler	3	4 50 per day	13 50	10 10	23 60
Jos. W Howe	Rodman	3	3 50 per day	10 50	10 10	20 60
Jos. Kiener	Laborer	3	2 25 per day	6 75	11 17	17 92
						$119 89

Special Surveys — Court of Claims.

(Chapter 950, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
M. W. Wilbur	First assistant engineer	10	$6 00 per day	$60 00	$13 90	$73 90
James W. Reed	Assistant engineer	9	5 00 per day	45 00	16 31	61 31
Geo. E Greene	Assistant engineer	3	5 00 per day	15 00	2 64	17 64
D. D. Waldo	Leveler	5	4 50 per day	22 50	7 02	29 52
Wm. Crennell, Jr	Leveler	5	4 50 per day	22 50	3 18	25 68
F. E. Holleran	Leveler	6	4 50 per day	27 00	17 36	44 36
Geo. J. Lord	Leveler	1	4 50 per day	4 50	1 76	6 26
H. D. Alexander	Leveler	6	4 50 per day	27 00	....	27 00
C. A Poole	Draughtsman	3	3 50 per day	10 50	....	10 50
James S. Cook	Chainman	3	2 50 per day	7 50	3 18	10 68
Clinton J. Bean	Chainman	6	2 50 per day	15 00	13 76	28 76
						$335 61

Extraordinary Repairs — Rebuilding Brighton Waste Weir and North Head Wall of Allen's Creek Culvert.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George E. Greene	Assistant engineer	24	$5 00 per day	$120 00	$10 20	$130 20
Wm. Crennell, Jr.	Leveler	25	4 50 per day	112 50	14 40	126 90
James S. Cook	Chainman	16	2 50 per day	40 00	9 50	49 50
						$306 60

Extraordinary Repairs — Rebuilding Berme Abutment of Jay Street Bridge, Rochester.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. H. Crafts	Leveler	64	$4 50 per day	$288 00	....	$288 00

Extraordinary Repairs — Rebuilding Culverts Nos. 1 and 2.

(Chapter 947, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Garrett O. House	Leveler	52	$4 50 per day	$234 00	$55 32	$289 32
S Girard Heater	Leveler	30	4 50 per day	135 00	1 34	136 34
Chas. E. Whitcher	Chainman	28	2 50 per day	70 00	3 25	73 25
						$498 91
Incidental expenses.						
Livery						66 00
Rent						16 00
						$580 91

Extraordinary Repairs — Canal Improvement.

(Chapter 79, Laws of 1895, Chapter 794, Laws of 1896, Chapters 43 and 569, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
J. L. Little	Division engineer	11 mos.	$3,000 per year	$2,750 00	$1,451 08	$4,201 08
C. R. Neher	Resident engineer	9 mos.	2,400 per year	1,800 00	996 87	2,796 87
M. W. Wilbur	First assistant engineer	351½	6 00 per day	2,107 50	991 41	3,098 91
H. A. Van Alstyne	Assistant engineer	287	5 00 per day	1,435 00	172 67	1,607 67
Boyd Eble	" "	317	5 00 per day	1,585 00	223 67	1,808 67
O. S. Wilson	" "	345	5 00 per day	1,725 00	247 26	1,972 26
James W. Reed	" "	129	5 00 per day	645 00	21 36	666 36
George E. Greene	" "	199	5 00 per day	995 00	92 68	1,087 68
W. L. Curtis	" "	289	5 00 per day	1,445 00	126 01	1,571 01
C. T. Middlebrook, Jr.	" "	80	5 00 per day	400 00	27 07	427 07
C. H. Flanigan	Leveler in charge	91	5 00 per day	455 00	74 14	529 14
C. H. Flanigan	Leveler	18	4 50 per day	81 00	22 97	103 97
G. O. House	"	185	4 50 per day	832 50	58 67	891 17
N. F. Hopkins	"	331	4 50 per day	1,489 50	44 55	1,534 05
Casper Schols	"	254	4 50 per day	1,143 00	2 38	1,145 38
H. D. Alexander	"	295	4 50 per day	1,327 50	14 07	1,341 57
Thomas J. Morrison	"	329	4 50 per day	1,480 50	....	1,480 50
George J. Lord	"	286	4 50 per day	1,287 00	10 20	1,297 20
William Crennell, Jr.	"	196	4 50 per day	882 00	44 83	926 83
L. B. Fitch	"	35	4 50 per day	157 50	2 83	160 33
E. A. Sommer	"	269	4 50 per day	1,210 50	45 64	1,256 14
Frank B. Clark	"	180	4 50 per day	810 00	35 35	845 35
F. E. Holleran	"	54	4 50 per day	243 00	3 92	246 92
Carl L. Lund	"	229	4 50 per day	1,030 50	13 66	1,044 16
S. G. Heater	"	59	4 50 per day	265 50	6 75	272 25
H. K. Bishop	"	218	4 50 per day	981 00	121 39	1,102 39
H. G. McKelvey	Draughtsman	229	4 00 per day	916 00	9 78	925 78
H. G. McKelvey	"	79	3 50 per day	276 50	....	276 50
C. A. Poole	"	230	4 00 per day	920 00	....	920 00
C. A. Poole	"	76	3 50 per day	266 00	....	266 00
Carl Bannister	Rodman	262	3 50 per day	917 00	31 62	948 62
James Thomson	"	239	3 50 per day	836 50	22 63	859 13
F. W. Hamilton	"	302	3 50 per day	1,057 00	30 08	1,087 08
E. R. Payne	"	313	3 50 per day	1,095 50	15 20	1,110 70
Irving Hawkins	"	41	3 50 per day	143 50	13 29	156 79
Joseph W. Howe	"	216½	3 50 per day	757 75	2 13	759 88
Isaac O. Cole	"	271	3 50 per day	948 50	1 83	950 33
S. D. Enoch	"	267	3 50 per day	934 50	29 72	964 22

Charles M. Smith	"	212	3 50 per day	742 00	16 28	758 28
Charles G Douw	"	72	3 50 per day	252 00	1 05	253 05
Fred D. Haak	Chainman	273	5 00 per day	1,365 00	267 26	1,632 26
Fred D Haak	"	91	4 50 per day	409 50	39 92	449 42
R. T. Webster	"	178	3 50 per day	623 00	29 68	652 68
Walter Dubey	"	321	3 50 per day	1,123 50	....	1,123 50
William Schneider	"	161	3 50 per day	563 50	....	563 50
F. G. Moses	"	331	2 50 per day	827 50	64 78	892 28
A. W. Peters	"	308	2 50 per day	770 00	10 50	780 50
James S Cook	"	177	2 50 per day	442 50	57 11	499 61
Clinton J. Bean	"	301	2 50 per day	752 50	33 92	786 42
F. Mauerman	"	263	2 50 per day	657 50	....	657 50
Charles E. Whitcher	"	32	2 50 per day	80 00	14 85	94 85
A. H. Wilcox	"	283	2 50 per day	707 50	....	707 50
R. W. Swanton	"	282	2 50 per day	705 00	....	705 00
W. F. Edgerton	"	41	2 50 per day	102 50	2 25	104 75
F. V. Searls	"	231	2 50 per day	577 50	....	577 50
Tracy B Smith	"	236	2 50 per day	590 00	41 71	631 71
W. F. Hurley	"	182½	2 50 per day	456 25	4 19	460 44
F. W. Gerstner	"	224	2 50 per day	560 00	8 94	568 94
E. J. Greiner	"	147	2 50 per day	367 50	10 80	378 30
						$55,917 40

Incidental expenses.

Labor	3,333 27
Livery	1,015 00
Printing and stationery	1,683 40
Fuel and light	124 03
Rent	924 88
Postage, Telegraph and Telephone	343 06
Miscellaneous	1,409 91
Stowell & Cunningham, preparing plans for lift locks at Lockport	5,811 58
Dutton Pneumatic Lock and Eng. Co., preparing plans for lift locks at Lockport	8,500 00
Buffalo Eng. Co., preparing plans for lift locks at Lockport	14,079 74
	$93,142 27

SUMMARY.

EXTRAORDINARY REPAIRS.	AUTHORIZED BY Chap.	AUTHORIZED BY Laws.	Amount.
Ordinary repairs	946	1896	$1,035 24
Porter avenue bridge, Buffalo	590	1895	2,224 23
Dredging lower Black Rock harbor	820	1894	806 57
Rebuilding vertical wall at Sodus street, Clyde	947	1896	61 95
Rebuilding vertical wall at Montezuma street, Lyons	947	1896	139 58
Enlarging spillway, Cuba reservoir	950	1896	200 00
Rebuilding vertical wall between South Clinton and South St. Paul streets, Rochester	947	1896	383 50
Improving channel of Falls creek, Montour falls	797	1896	500 00
Dyke along Chemung river at Chemung	949	1896	500 00
Dredging and removing obstructions, Findley's lake	950 790	1896 1897	126 94
Repairing highways Cattaraugus Indian reservation from Lawtons to Versailles	949	1896	32 33
Completing bridge across Cattaraugus Creek at Versailles	950	1896	150 00
Repairs to Dock in Erie Basin	489	1896	100 00
Buoys in Erie Basin	521	1896	23 00
Improving channel of Newtown creek	949 791	1896 1897	2,467 72
Exchange street bridge, Rochester	514 572 791	1896 1897 1897	75 00
Bridge over Oak Orchard feeder, Medina	791 790	1896 1897	71 55
Rebuilding Newark waste weirs	947	1896	390 00
Replacing 2 24-inch pipes with 1 48-inch pipe under Erie canal between Ninth and Tenth streets, Rochester	947	1896	333 00
Dyke along the Chemung river, Elmira	950 790	1896 1897	1,088 89
Building bridge and improving State roads, Tonawanda Indian Reservation	950 790	1896 1897	200 00
Improving channel leading from State culvert under Erie canal at Brockport	947	1896	165 48
Deepening and improving Cayuga creek	559	1897	193 21
Deepening and improving Mud creek	477	1896	340 60
Repairing and preserving highways on the Cattaraugus Indian Reservation	790	1897	54 48
Constructing a bridge over the Allegany river between Carrolton and Allegany	790	1897	182 40
Genesee river storage dam	950	1896	2,598 29
Repairing abutments of Cook's bridge and lengthening culverts 33 and 34, and rebuilding culvert 32, all in Pittsford	947	1896	258 66
Building temporary aqueduct and coffer dam at Lockport	947	1896	120 00
Rebuilding iron culvert under Genesee river feeder at Rochester	947	1896	227 50
Rebuilding and repairing culverts 36 and 38 at Brighton	947	1896	482 70
Rebuilding culvert between Medina and Knowlesville	947	1896	502 00
Repairing waste weirs at Lockport, Middleport and near Mabee's bridge	947	1896	185 20
Removing old pile dam across Chemung river at Corning	790	1897	88 83
Repairing and preserving highways on the Allegany Indian reservation	790	1897	119 89
Special surveys court of claims	950	1896	335 61
Rebuilding Brighton waste weir and north head wall of Allen's creek culvert	947	1896	306 60
Rebuilding berme abutment of Jay street Bridge, Rochester	947	1896	288 00
Rebuilding culverts Nos. 1 and 2	947	1896	580 91
Canal improvement	79 794 43 569	1895 1896 1897 1897	93,142 27
			$119,584 08

DETAILED STATEMENT

OF THE

EXTENT AND PRESENT STATUS OF ALL CANAL IMPROVEMENT CONTRACTS

ON THE

WESTERN DIVISION,

EMBRACING

All of the Erie Canal from the East Line of Wayne County to Buffalo, N. Y.

SUBMITTED BY J. L. LITTLE, DIVISION ENGINEER.

Extent and Present Status of all Canal Improvement Contracts on the Western Division.

CONTRACT No. 1.

Dated, November 5, 1896. Donnelly Contracting Company, contractors.

Engineer's estimate	$433,225 00	
Additional work authorized by canal board	35,920 00	
		$469,145 00
Estimate at contract prices		394,955 00
Work done including 10 per cent retained		556,060 00

This contract extends from station 83+10, near Ferry street, to the Commercial slip in the city of Buffalo, and including Commercial slip and slips Nos. 1, 2 and 3, a distance of 3.45 miles.

The work done under this contract presented difficulties not met with on any other portion of the canal. This section of the canal connects directly with Lake Erie through Commercial slip and slips Nos. 1, 2 and 3. Lake Erie, through these slips and through an entrance from the harbor near the International bridge on contract No. 2, furnishes, during the greater part of the year, almost the total feed of water for the entire western division of the canal. The water surface of Lake Erie, due to the small depth of the lake and to high winds, varies greatly, and the water surface of the canal from the lake to the Black Rock guard lock on contract No. 2, varies accordingly. For this rea-

son it was decided on this section of the canal to excavate deep enough to obtain at least 9 feet of water in the canal when Lake Erie's water surface was at its lowest. After examining all available records, an elevation of 569 feet above tide water was decided upon as Lake Erie's low elevation during the season of navigation. This made the new canal bottom 560 feet above tide water. The old canal bottom was originally 562.02, which would make the cut for the new canal bottom two feet. Ever since the canal was built, the city of Buffalo has been allowed to empty a large number of sewers into it, and as a result the cut, instead of being two feet, averaged four feet, the cutting near the berme bank running as deep as eight feet. This made the quantities of excavation run much higher than the preliminary estimate showed, though the quantities on the bidding sheet, 159,000 cubic yard of earth and 101,100 cubic yards of rock will approximate closely to the actual amounts excavated from the canal prism. A portion of this section of the canal was drained about 25 years ago, but the records of the work done then are meager and no records can be found as to when the other portion was drained.

No records could be found showing the section of the vertical walls, the elevations of their foundations, or the material on which they were founded, and the same applies to all the older bridge foundations. In order to drain this section of the canal, six dams were erected, one across the Erie canal at Commercial street, one across slip No. 1, one across slip No. 2, one across slip No. 3 and one across the Erie canal at Ferry street. Another dam for protection was placed across the canal near Georgia street.

On January 1, 1897, the canal between Georgia street and Ferry street had been pumped dry and the work of excavation started,

and on February 20th all of the section was dry and the condition of the canal bottom could be seen. The whole bottom was covered with sediment running from about 2 feet deep in the center to four on the towpath and six on the berme bank. The stench arising from this sediment, especially between Georgia and Commercial streets was very bad and the sediment being too soft to allow men or teams to work in it, no excavation could be made till it had dried out, and this would not happen until the Buffalo sewers were made to empty elsewhere. The city had been notified some time before that no sewers would be allowed to drain into the canal during the improvement work and were ordered to make arrangements to that end. Nothing was done for some time but finally the contractors constructed a wooden box sewer along the foot of the berme wall, which caught the sewerage, carried it to the Commercial street dam, where it was pumped over the dam into the Commercial slip. The work of excavation then started. The city board of health immediately began to object to the depositing of the excavated material on the spoil banks on account of the smell, and the owners of the land appropriated temporarily for spoil banks objected for the same reason, and obtained injunctions restraining the contractor from depositing the excavation on their property. Lime and other disinfectant were used to lessen the smell and the courts set aside the injunction. A delay of one month was caused by injunctions obtained by the owners of the abandoned portion of the Evans ship canal which was wanted for a spoil bank. The United States Government, by military force, also seriously delayed work for one month. The land in front of Fort Porter between the N. Y. C. Ry. and the canal, which all State records show that the State owns, was needed for a spoil bank and is the only available

spoil bank between Ferry street and the N. Y. C. Ry. bridge, a distance of 0.9 miles.

The United States Government however, also claimed the land and before it could be used by the State, permission had to be obtained from the Secretary of War. The title of this land is still in dispute though there is no doubt but what it is State property.

When the estimate for this contract was made, due to the impossibility of then draining the canal and to the meager records in regard to the conditions of wall and structures as before noted, the quantities named in the estimate, with the exception of the excavation in the canal prism, were largely questions of guess work.

Not knowing the elevations of the foundations of the vertical walls, it was impossible to know how much of the wall would fall in when the canal excavation was made, and as a result, it was impossible to more than guess at the amount of new wall needed, the amount of excavation necessary to build new wall, the amount of embankment and lining that would have to be placed behind the new wall and the timber necessary for the foundations. The character of the material to be excavated from the canal prism was of such various character that it was a difficult matter to estimate how much this material, measured in excavation, would measure in embankment. On this depended the amount of embankment that would have to be paid for, as all material excavated and hauled more than 1,000 feet before it was deposited, had to be paid for both as excavation and embankment. Therefore the amount of material that a given piece of land would hold had to be determined before the embankment could be calculated. A large portion of the material excavated

was so soft that it was semi-fluid, and as a result it was impossible to deposit on a number of spoil banks the yardage that had been calculated upon, as the deposit could not be piled as high as had been figured on. Other spoil banks had to be acquired and in all cases these were beyond the limit of haul, 1,000 feet, and all this material, there deposited, had to be paid for as embankment in addition to the price for excavation. The amount of embankment in the final estimate will, on this account, exceed that shown in the bidding sheet and estimate.

It was expected when the contract was let, that nothing would have to be done with any of the bridge abutments, but on April 21st, the abutments of the Genesee street bridge began to fall. The bridge was moved, new abutments built and the bridge replaced. During the month of July, 1897, rain fell on 20 days, and the records show an aggregate precipitation of 7.52 inches. On the 11th of July, 2.02 inches fell between 5 p. m. and 7 p. m., and the water brought into the canal by the Buffalo City sewers filled the canal with water to a depth of 3½ feet in spite of the fact that 14 pumps varying in size from 6 to 12 inches discharge, and with a capacity of 91,000,000 gallons per 24 hours, were constantly at work. Owing to the increased cross sections of the canal prism due to the excavation at that time finished, the amount of water in the canal on the evening of July 11th was equal to the total amount of water in the canal before it was first drained. During this storm the Erie street sewer, which empties into the canal through the center of the berme abutment of the Erie street bridge became overcharged and bursted in the rear of the abutment. The foundation of this abutment was 13 feet above new canal bottom, but it was hoped that it would be possible to save both this and the towpath abutment, which

was in the same shape, by a system of sheet piling. But when the sewer bursted, the water started under and around the abutment, soon undermining it. An attempt was made to hold the bridge and abutments by the aid of braces, but in spite of all efforts, on July 13, 1897, three of the five trusses and half of the berme abutment fell into the canal. It was then decided that new abutments must be built. Before this could be done, it was necessary that two large tenement blocks bordering on Erie street and the canal, should be underpinned. These buildings were close to the canal, their foundations were but a few feet below the towpath level and a settlement in the buildings was noticed soon after the bridge fell. The buildings were deemed unsafe and the tenants were ordered to vacate. By this time, July 13th, work on this contract was so far completed that water could be let into the canal if the Erie street bridge had not fallen. It was necessary, in order to underpin the buildings before mentioned, and to rebuild the Erie street bridge abutments, that the canal should be kept drained.

It was then decided to order another dam built at Charles street about 200 feet east of Erie street, thus allowing boats to enter the canal through slips Nos. 1, 2 and 3. This dam was built and water was let into this section of the canal on August 7th. The specifications for this contract stated that work must be so far advanced as not to interfere with the opening of navigation on May 1, 1897. But on account of the various delays above mentioned, which were not due to any lack of enterprise on the part of the contractor, it was decided to extend the time for the completion of the work. In order not to stop navigation, the contractor agreed to tow all canal boats, loading in the various basins, through the harbor and into the canal through the opening between the harbor and the canal near the International bridge, and also to tow all boats, coming from the east, from the International bridge to the basin. This was entirely

satisfactory to the boat owners, the only people objecting to the arrangement being owners of the different stores and warehouses situated on the banks of the closed portion of the canal. The vertical walls on the section from Ferry street to Porter avenue stood in very good shape, as most of them were founded on rock. The walls on the rest of the contract stood fairly well until early spring, when the frost in the ground began to leave. The height of the vertical walls varied from 14 to 28 feet. Up to May 1st only 1,045 cubic yards of vertical wall had been relaid while, owing to walls falling in after that time, the final estimate will show about 30,000 cubic yards, all of which it was absolutely necessary to rebuild.

The contractors for this work are the Donnelly Contracting Company. Tables and a profile annexed show the cost of the work up to date, and a typical cross section of the canal. In the construction of the dams, the contractors used 373,000 feet B. M. of lumber and 2,200 lineal feet of piles. In the runways, to enable teams to haul loads from the canal bottom to the spoil banks, 286,000 feet B. M. of lumber was used. In soft canal bottom and on spoil banks 5,100 lineal feet of plank roadway was laid, consuming 336,000 feet B. M. of lumber. In excavating the rock, 120,000 holes, spaced about 5 feet apart and from $1\frac{1}{2}$ to 2 inches in diameter and varying in depth from 2 feet to 5 feet, were drilled, aggregating about 80 miles of penetration. About 72 tons of 40 per cent. dynamite was used; 102,000 cubic yards of rock, for the most part flinty lime stone, was excavated. As all this work is in a thickly settled portion of the city, all blasts had to be covered with heavy timbers chained together; 200,000 feet B. M. was destroyed in this way. In drilling, 46 steam and electric drills were used. In cold weather the electric drills did the best work and in warm weather the steam drills. The electric drills had the advantage in that the power is delivered to them through wires suspended on movable poles and so allow

the passing of teams, while the surface of the area around a gang of steam drills is so covered by steam hose that such passage is impossible. Any laborer of ordinary intelligence can run an electric drill and thus the cost of labor per drill is less for the electric than for the steam drill. About 224,000 cubic yards of earth has been excavated.

From Ferry street to the N. Y. C. railway bridge, the excavation was done by the use of four revolving traveling McMyler derricks, with 55 and 65 feet booms, placed in the canal bottom and loading into dump cars on the towpath. The derrick skips held 1½ yards. Two locomotives were used to haul the cars to the spoil banks. This method of handling the excavation has been the most satisfactory so far seen on this division, and as near as can be learned, earned the contractor a good profit, his price being 35 cents for earth, $1.53 for rock and 45 cents per yard for all material hauled over 1,000 feet.

Aside from a small amount of earth taken out by dredges, all the rest of the excavation was taken from the canal bottom by wagons and dump carts. The profit, if any, to the contractor on this part of the work was small. The assistant engineer in charge of this work is O. S. Wilson.

CONTRACT No. 2.

Dated, November 4, 1896, Buffalo Dredging Company, contractors.

Engineer's estimate	$287,834 00	
Additional work authorized by the canal board	167,894 00	
		$455,728 00
Estimate at contract prices		291,686 00
Work done including 10 per cent. retained		321,990 00

This contract extends from station 328, section 21, near McDonalds culvert to station 87+10, section 23, near Ferry street, Buffalo, N. Y., a distance of 22.07 miles.

Before entering into the details and character of the work contemplated under this contract, it will be necessary to state briefly the location of this portion of the canal. Reference can be made to the profile annexed. From Ferry street, where contracts Nos. 1 and 2 join, to the Black Rock guard lock, a distance of 1.58 miles, the canal preserves the same general cross section as on contract No. 1. From the guard lock to Tonawanda, a distance of 7.93 miles, the canal runs parallel with the Niagara river and only a short distance away, and the section is much smaller, necessitating an increased depth and grade to obtain the required flow of water; from Tonawanda to Pendleton, a distance of 11.62 miles, the Tonawanda creek is used and the cross section is large so that the required depth of 9 feet of water was sufficient; from Pendleton to McDonalds culvert, a distance of .94 miles, the channel was not so wide, and a slight grade was given to the bottom to create a swifter current. The exact elevations of the old and new surface and grade can be seen on the profiles accompanying this report.

No part of the canal covered by this contract, so far as can be learned, has been drained since it was constructed, and as it is impossible to drain the greater portion of it, all the work was let on the supposition that it was to be dredged. Included in this contract, besides the excavation, were four items. (1) Lowering the Black Rock guard lock. (2) Rebuilding the Cornelius creek culvert and (3) rebuilding the 3 mile creek culvert and (4) rebuilding the Tonawanda State ditch culvert. All of these structures are situated between Black Rock and Tonawanda. In order to

drain the canal for the construction of these structures instead of coffer-damming each structure by itself, a dam was put across the canal above the guard lock and another below the State ditch culvert in Tonawanda. At Tonawanda, the surface of the canal water is about four feet above that of the Niagara river. The river lock at Tonawanda was opened before the State ditch dam was made tight and the canal drawn to river level. The dam was then completed and the remainder of the water pumped out. The work on the guard lock consisted in lowering the floor 18 inches, putting in new mitre gates, replacing disintegrated quoin stones, rebuilding the pier head and cutting checks in the lock walls for use in constructing temporary dams when it may be necessary to drain the locks. The old plans for this lock showed it founded on piles, and plans for the improvement were made accordingly. On removing the old floor it was found that what piles were under it were in such an unstable condition that they were useless. A large part of the lock floors were founded on mud sills only. This necessitated almost an entire change of plan. The new floor consists of 3-inch by 12-inch hemlock and pine planks, planed and laid on edge close together. These are covered by a course of 2-inch planking. The use of both pine and hemlock is accounted for by the fact that the lumber had already been delivered according to the original plan when it was found necessary to make lumber then on hand, after being cut to the correct sizes, was a change, and in order to lessen the cost as much as possible, all used. Before starting on the work, the locks were braced and roofed over, the old floor was then taken out in sections of from 10 to 12 feet and the new floor put in. The new floor extends under the old lock walls about 18 inches. Concrete and wooden wedges were used to fill up the space between the top of the new

floor and the bottom of the old walls. The work was necessarily a slow and difficult task, but was accomplished without damage to the old structure and no signs of settlement or failure has been noticed during the past summer. The three culverts, Cornelius creek, three mile creek and Tonawanda State ditch, are all similar in construction and location, though varying in size. All empty into the Niagara river and all are "dive" culverts. This necessitated the construction of coffer dams around outlet ends. Cornelius creek consists of 4 lines of 60-inch cast iron pipe, 146 feet long; 3 mile culvert of 1 line of 48-inch cast iron pipe, 169 feet long and Tonawanda State ditch culvert of 6 lines of 72-inch cast iron pipe, 193 feet long. The wings, end walls and parapets on all three were constructed of Oil City sand stone. These culverts have served their purpose well during the past summer. The portion of the canal between contract No. 1, and the guard lock was dredged during the last year and is now completed. No trouble was anticipated from the falling in of walls, due to increasing the depth of the canal, on this section, and it was not estimated that any would have to be rebuilt. The material forming the canal bottom was for the most part a plastic clay, overlying a flinty lime stone rock. The elevation of the top of the rock varied from 2 feet above to 8 feet below new canal bottom. The vertical walls were for the most part built on cribs. The elevation of the bottom of the cribs was not known, nor their dimensions, nor the section of the walls. In some places, at the time, and in other places, weeks after the excavation had been made these walls and cribs on the towpath side in different places, began to slide, settle and fall into the canal, and it was found necessary to rebuild them. The total length rebuilt was 2,298 feet. The Bird avenue, Buffalo sewer, 4 feet in diameter, runs

along the towpath from 10 to 20 feet from the front angle and at an average depth of 7 feet below the towpath level, from Bird avenue to near Ferry street. The Niagara Falls conduit, 2 feet square, runs along the towpath from 12 to 15 feet from the front angle and about 2 feet below the towpath level. In every case where the walls started to slide or settle, the first sign noted was the cracking of the towpath over the lines of either the sewer or the conduit. In my opinion the failure of these old walls was due, not so much to the canal excavation as to the cutting of the solid towpath bank by the sewer and conduit.

It being impossible to drain this section and the distance to rock being too short to allow a pile foundation, it was necessary to dredge out the old walls and towpath, put in cribs and on them build the new wall. The cribs were 8 feet wide and from 20 to 70 feet long. They were anchored to "dead men" placed 50 feet back of the front angle by 1-inch wrought iron tie rods. In most cases work stood well. But for a distance of 72 feet where the bottom of the crib rested on or very near the rock, after the back filling was put in, these new cribs started to slide, the pressure of the earth breaking the tie rods above mentioned.

This work was then torn out for a second time, the cribs replaced and larger tie rods 1½ inches in diameter put in. To add to the safety of the construction, loose stone back filling was put in and where the depth of earth below the crib bottom allowed it, piles were driven in the corners of the crib pockets. Where the cribs rested on or near the rock, holes 2 feet deep were drilled in the rock in front of the cribs, and in these holes were placed wrought iron rods 3 inches in diameter extending up the front of the crib 1 foot. Since this work was completed no sliding or settlement has taken place. In addition to the re-

building of these walls, 2,400 feet of old wall was protected by driving piles in front of it. From the Black Rock guard lock to Tonawanda, as before noted, the canal runs parallel with the Niagara river and in places very close to it. The surface of the canal water is from 3 to 4 feet above that of the river. It was expected that nothing would have to be done with the slope and vertical walls on this section of the contract, as the walls, as far as could be seen with the water in the canal, were apparently in fair shape. After the water had been drawn, the slope walls were found to be badly bulged and the foundation timber, instead of being at old canal bottom as was supposed, was found to be all the way from 3 to 5 feet up the slope, thus leaving the bottom of the slope unprotected. An attempt was made to excavate the canal to its new grade and to underpin the slope walls, but the canal banks were found to be built of a heavy clay which would not stand at necessary slope. Due in part to the weight of the bank itself and in part to the water pressure from the Niagara river, the canal banks began to slide towards the canal center. This was especially so where the excavation above mentioned was made, but the sliding occurred where no excavation had been made. It was then decided that it would be unsafe to allow the contractors to proceed with any excavation, either dry or by dredging, until all of the walls had been in some manner protected. At the toe of the slope wall it was decided to drive a continuous line of 6 inch beech or maple sheet piling 12 feet long and where the wall was particularly bad, to relay and rebuild it. The berme bank of the canal is very high and composed of clay.

Along the top runs a highway. No wall exists on this side, but a row of piles, badly rotted, had been driven along the foot of the slope to keep the bank from sliding. On account of the

proposed increased depth it was decided to further protect portions of this bank by more piles and by sheet piling. Near Tonawanda, where both sides of the canal have vertical walls whose foundations are from 3 to 5 feet above new grade, a pile and sheet piling protection was ordered. The extra material that had to be ordered for this protection is as follows:

Beech and maple, 4,039,000 feet B. M.

Hemlock, 309,000 feet B. M.

Oak, 64,000 feet B. M.

Oak piles, 14,280 lineal feet.

Beech or maple piles, 20,000 lineal feet.

Iron, 25,000 lbs.

The large size of this bill of timber made it almost impossible to get it on the ground in time to do any work during the winter of 1897. Most of this material was delivered during the past summer and the work on that portion which it was possible to put in place while the water is in the canal has been done. In order to put the rest in place the canal will have to be drained again during the coming winter. A price for this item has been agreed upon.

From Tonawanda to Pendleton, the Tonawanda creek being used, no especial difficulties were encountered, the improvement consisting of dredging in order to obtain the required depth of water. From Pendleton to McDonald's culvert, the end of this contract, the work has been carried on as planned; 3,308 lineal feet of vertical wall on piles was built as was estimated in planning the work. During the summer a small amount more fell in and will have to be rebuilt during the coming winter. The contractors for this work are the Buffalo Dredging Company. They have prosecuted the work with as much vigor as could be required. In constructing the coffer dams, runways and flumes,

285,000 feet B. M. of lumber and 4,000 lineal feet of piles were used. In pumping the "Black Rock to Tonawanda" section, 7 pumps varying in size from 6 to 14 inches and with an aggregate capacity of 40,000,000 gallons per day of 24 hours were used.

In dredging, 5 dipper dredges were used with the following dipper capacity:

Dredge No. 1, 1½ cubic yards.

Dredge No. 2, 2½ cubic yards.

Dredge No. 3, 2 cubic yards.

Dredge No. 4, 2½ cubic yards.

Dredge No. 7, 1½ cubic yards.

Dump scows were used. The capacity varied per scow from 80 yards to 150 yards and four tugs were used in towing the scows to the dumping ground. The contractors had to supply their own dumping grounds except that they were allowed to dump in such portions of Tonawanda creek where the water was over 12 feet deep below low water surface. Tables annexed show the details of the estimate cost of the work. Except for the increased quantities in vertical and slope wall and in lumber, the amount of work that will appear in final estimate will approximate closely to that shown in the bidding sheet.

During the progress of the work, the contractors were handicapped in several ways. The winter happened to be a very open one and on account of the bad conditions of the roads, in hauling stone from the quarry and railway to the Pendleton wall, a distance of about five miles, four and six horses had to be used on each wagon. On March 12th, due to very heavy rains and winds the dam across the canal near the Tonawanda State ditch began to leak badly and it took several days to repair the damage done. At the foot of Franklin street, Tonawanda, a city sewer crosses under the canal. The city was ordered to lower

this sewer so as not to interfere with the new canal bottom. On February 6th, this sewer began to leak and the water from Niagara river began to back up through the sewer and threatened to flood the canal. The contractors were ordered to put in earth dams on each side of this sewer so as to protect the canal work. This item also increases the cost of work done under the contract, though the city of Tonawanda should reimburse the State for this expenditure.

At the time, the city of Tonawanda was ordered to do this work, but were so slow in getting at work that, in order to protect the State from damage claims from the contractor, it was deemed advisable to order the contractor to do this work himself, the State being responsible for the pay.

It is expected that the wall protection between Black Rock and Tonawanda will be completed during the coming winter and that during the summer of 1899, the remaining dredging will be done. Boyd Ehle, up to August 27, 1897, was assistant engineer in charge of this work and since that time, E. A. Sommer has had charge.

CONTRACT No. 3.

Dated November 7, 1896, Chas. F. Parker & Co., contractors.

Engineer's estimate	$312,510 00
Additional work authorized by Canal Board	$312,510 00
Estimate at contract prices	188,542 00
Work done, including 10 per cent. retained	61,040 00

This contract extends from the head of the Lockport locks to station No. 328, near McDonald's culvert, section No. 21, a distance of 5.83 miles.

With the exception of lowering the Sulphur Springs Guard locks, all the work contemplated under this contract consists of excavation and of the building of vertical and slope walls.

From McDonald's culvert, easterly to the head of the rock cut, a distance of 3.23 miles, the canal prism being wide enough, a uniform depth of 9 feet of water was decided upon. From that point to the Lockport lock, a distance of 2.60 miles, the canal runs through a heavy rock cut and the prism was much narrower. As a result, in order to deliver at the head of the Lockport locks waters sufficient to feed the lower levels, a uniform depth of water of 13 feet was decided upon. The grades and water surfaces, old and new, can be seen on the annexed profile.

The Black Rock guard lock, which is closed whenever Tonawanda creek rises and threatens to "back up" through the canal and endanger the Lockport lock (as was explained in last year's report), is founded on rock, and no difficulty was experienced in lowering it. The mitre sills were removed, the rock excavated to the required depth, new sills and gates put in and the entire structure repointed. New vertical walls were built where thought necessary between McDonald's culvert and the Sulphur Spring guard lock.

Through the rock cut to the Lockport locks, 2.60 miles, the cut, in solid limestone rock, averages 5 feet. The work on this section progressed much slower than was desired. The machinery used did not work well nor do what was expected. But 32,000 cubic yards of rock out of 161,000 cubic yards, estimated, was taken out during the winter. As the canal prism through this rock cut is so narrow, it was decided to channel both sides. There was estimated 141,000 square feet of channeling, and of this 38,000 square feet has been finished. During the summer a small dredge has been at work on the earth excavation, but

complished very little. All the prices for the large items on this contract are very low, the total amount of the contract, as let, being over $40,000 lower than the next lowest bid submitted.

In excavating material, besides the ordinary methods, four cableways were used—three in the rock cut and one west of the guard lock. These cables were anchored to towers placed on either side of the canal. The towers were on tracks, so that the whole cable-way could be moved parallel with the canal. A single bucket of two cubic yards' capacity was used on each cable-way. This bucket was loaded in the canal bottom with material brought near it by wagon or cars. The motive power was located in one of the towers. The working of these cable-ways was too slow to do the work required or expected. For blasting, all holes were drilled by steam drills. Twelve drills were used.

Six channelers were used in the channeling. In addition to the plant used last year, the contractors expect to put in a number of McMyler machines, steam shovels and cars, and have promised to complete the contract during the coming year. H. A. VanAlstyne has been in charge of this work as assistant engineer.

CONTRACT No. 4.

Dated November 5, 1896, Whitmore, Rauber & Vicinus, contractors.

Engineer's estimate	$10,287 00
Additional work authorized by the Canal Board	$10,287 00
Estimate at contract prices	8,545 00
Final account	11,097 00

This contract consisted in building the Cartersville waste-weir and spillway at station 721, section 15.

The Cartersville waste-weir is situated in the towpath bank on the 17-mile level a short distance east of the village of Pittsford. For years it had been in bad condition and has been held in place by timber bracing. As the bottom of the gates in the old structure were too high to drain the deepened canal, and as the old structure was in too poor a condition to allow of larger and deeper gates being put in, it was decided to build a new structure. The contract was let to Whitmore, Rauber & Vincinus, of Rochester, and was finished before the opening of navigation in 1897, this being the only contract under the "improvement" work on this division that has been finished. The estimate contract price and final cost of this work can be seen on Table No. 1, annexed. The increase of final cost over contract price was due chiefly to the fact that the rock excavation necessary to obtain a good foundation was larger and that more puddle and lining was used than has been estimated. The masonry was also increased over that shown on the original plans by making the cut-off walls larger and by increasing the length of the east wing wall. Plans and photographs annexed give a good idea of the old structure and of the size and construction of the new weir. The waste-weir has so far performed all duties expected of it and has shown no signs of settlement or failure. George E. Greene has been in charge of this work as assistant engineer.

CONTRACT No. 5.

Dated, January 23, 1897, Grannis & O'Connor, contractors.

Engineer's estimate	$227,102 00	
Additional work authorized by canal board	53,929 00	
		$281,031 00
Estimate at contract prices		217,120 00
Work done including 10 per cent. retained........		113,850 00

This contract extends from the upper mitre sill of lock No. 61 to the lower mitre sill of lock No. 62, a distance of 17.16 miles.

The section of the canal included in this contract starts in the village of Macedon and ends near the village of Pittsford and includes what is known as the "17 mile level." It was decided to do this work as soon as possible as this level was in very bad condition. The old canal bottom was level and the water surface was supposed to have a fall of .333 feet. Great difficulty has always been found in keeping the proper depth of water in the Macedon, or lower end of the level. It was decided, that, in order to overcome this difficulty, to give a grade to the new bottom, in the 17.16 miles, of 0.5 feet, and to make the water surface parallel with and 9 feet above the bottom. This would increase the current and tend to keep the depth of the water over the whole level about the same. It cannot be stated as yet whether this change in grade and water surface will relieve the difficulty mentioned, as the work is not as yet far enough advanced. The contract for this work was not let until January 23, 1897, and so no great progress was made during the past year. It is expected that the work will be finished during the coming year.

Aside from excavation, vertical and slope wall, the following are the principal items of work included in this contract.

(1) The repairing of the abutments of bridges Nos. 41, 43, 44, 47, 48, 49, 51, 52, 53, 54 and 55.

(2) The rebuilding of the berme abutments of bridges Nos. 42 and 50 and the maintaining of temporary bridges while construction is going on.

(3) The rebuilding and repairing of culverts Nos. 26, 27 and 31.

(4) The rebuilding of White's receiver.

No work has been done as yet on any of the structures mentioned above. During the month of April, the berme abutment

of Frear's bridge No. 61, due to being founded on quicksand, and 3 feet above canal bottom, began to slide. The bridge was removed and the abutment rebuilt. At the end of this year 54,000 cubic yards of material had been excavated. For excavating this material while the canal was dry besides wheel barrows, three derricks set on the towpath and revolving through half a circle were used. Each derrick handling skips holding from 1 yard to 1½ yards. The skips were loaded by hand. The derricks were not self propelling and had to be moved by hand. Owing to this and to the fact that they worked slowly and were too lightly constructed for the work expected of them, they were not a great success. During the summer, two dredges have been at work. One a small dredge with a ¾ yard dipper has done but little work owing to being broken down a good part of the time. The other, a large 1¾ dipper dredge, did not get on the work till late in the year, and while working well, has not as yet done much work.

In underpinning slope walls, this is the only contract so far let on this division, where such work has been done. Natural cement concrete was used and was found to be far from successful. Hereafter stone will be used, being cheaper and apparently better, especially in freezing weather. During the coming year the contractor expects to use more derricks and dredges, and promise to push the work. Gannis & O'Conner of Syracuse are the contractors.

C. H. Flanigan was engineer in charge up to June 7, and since that time, H. K. Bishop.

CONTRACT No. 6.

Dated, September 23, 1897, Furnaceville Iron Company, contractors.

Engineer's estimate	$166,090 00
Estimate at contract prices........................	165,800 00
Work done including 10 per cent. retained	6,440 00

This contract extends from 1,000 feet west of bridge No. 148 to the foot of the Lockport locks, a distance of 8.45 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 7.

Dated, September 3, 1897, Baker & Banker, contractors.

Engineer's estimate	$99,725 00
Estimate at contract prices	98,760 00
Estimate at contract prices including 10 per cent. retained	7,600 00

This contract extends from Shelby Basin bridge No. 142 to 1,000 feet west of bridge No. 148, a distance of 5.87 miles.

The work to be done under this contract will consist of deepening the canal 2 feet, and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 8.

Dated, September 21, 1897, Williams, McNaughton & Bapst, contractors.

Engineer's estimate	$191,090 00
Estimate at contract prices	184,095 00
Work done including 10 per cent. retained	5,940 05

This work extends from 700 feet west of Long's bridge No. 134 to Shelby basin bridge, No. 142, a distance of 8.50 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 9.

Dated September 23, 1897, Furnaceville Iron Co., contractors.

Engineer's estimate	$114,440 00
Estimate at contract prices	111,000 00
Work done including 10 per cent. retained	27,280 00

This contract extends from Braileys bridge No. 125, to 700 feet west of Long's bridge No. 134, a distance of 6.06 miles.

The work to be done under this contract will consist of deepening the canal 2 feet, and rebuilding and underpining any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 10.

Dated September 23, 1897, Furnaceville Iron Co., contractors.

Engineer's estimate	$152,090 00
Estimate at contract prices	135,500 00
Work done including 10 per cent. retained	2,780 00

This contract extends from 1,000 feet east of Holley bridge No. 115, to Brailey's bridge No. 125, a distance of 8.44 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 11.

Dated September 23, 1897, Furnaceville Iron Co., contractors.

Engineer's estimate	$116,385 00
Estimate at contract price........................	110,100 00
Work done including 10 per cent. retained........	12,360 00

This contract extends from Cooley's Basin bridge No. 106 to 1,000 feet east of Holley bridge, No. 115, a distance of 6.63 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 12.

Dated September 23, 1897, Furnaceville Iron Co., contractors.

Engineer's estimate	$96,540 00
Estimate at contract prices......................	87,000 00
Work done including 10 per cent. retained.........	3,790 00

This contract extends from 600 feet east of Normans bridge No. 97, to Cooley's Basin bridge No. 106, a distance of 6.04 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 13.

Dated September 18, 1897, Henry C. Allen & Co., contractors.

Engineer's estimate	$119,727 00
Estimate at contract prices......................	105,850 00
Work done including 10 per cent. retained.........	11,900 00

This contract extends from Rowe street bridge, Rochester, No. 86, to 600 feet east of Norman's bridge, No. 97, a distance of 8.14 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 14.

Dated September 20, 1897, Whitmore, Rauber & Vicinus, contractors.

Engineer's estimate	$169,830 00
Estimate at contract price	159,695 00
Work done including 10 per cent. retained	....

This contract extends from lock No. 66 to Rowe street bridge, Rochester, No. 86, a distance of 4.38 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price. This contract extends through the city of Rochester.

CONTRACT No. 15.

Dated September 20, 1897, Whitmore, Rauber & Vicinus, contractors.

Engineer's estimate	$90,915 00
Estimate at contract price	88,595 00
Work done including 10 per cent. retained	....

This contract extends from lock No. 62 to lock No. 66, a distance of 4.83 miles.

The work to be done under this contract will consist of deepening the canal 2 feet and rebuilding and underpinning any slope and vertical wall that may be necessary. The work is not yet far enough advanced to say whether the final cost will exceed the contract price.

CONTRACT No. 16.

Engineer's estimate $499,000 00

This contract will consist in building a pneumatic lift lock in place of the five combined locks at Lockport, N. Y. The plans for this work have been approved by the Canal Board.

CONTRACT No. 17.

Engineer's estimate $125,557 00

This contract will extend from lock No. 56 to 1,400 feet west of Port Gibson bridge No. 30, except from lock No. 57 to lock No. 59, a distance of 7.22 miles. The work will consist of deepening the canal the required depth; in rebuilding the berme abutment of bridge No. 30, and in rebuilding and repairing vertical and slope walls.

CONTRACT No. 18.

Engineer's estimate $61,135 00

This contract consists in lowering and repairing locks Nos. 62, 63, 64, 65 and 66.

CONTRACT No. 19.

Engineer's estimate $94,916 00

The work under this contract will consist in rebuilding waste weirs Nos. 1 and 2, lowering the Palmyra and Lyons aqueducts,

lowering and repairing locks Nos. 54, 55, 56 and 60, replacing gates in lock No. 61 and lowering the top of culvert No. 16.

CONTRACT No. 20.

Engineer's estimate $98,185 00

This contract extends from lock 54 to lock 56, a distance of five miles. The work will consist in deepening the canal to the required depth, in rebuilding the berme abutment of bridge No. 19 and in rebuilding and repairing slope and vertical walls.

CONTRACT No. 21.

Engineer's estimate.............................. $66,438 00

This contract extends from lock No. 53 to lock No. 54, a distance of 3.10 miles. The work will consist in deepening the canal to the required depth, in relaying pipe culvert No. 11, in rebuilding culvert No. 12 and in rebuilding and repairing slope and vertical walls.

CONTRACT No. 22.

Engineer's estimate.............................. $128,334 00

This contract extends from the east line of Wayne county to lock No. 53, a distance of 7.72 miles. The work will consist of deepening the canal to the required depth and raising the banks to the required height, in raising bridges Nos. 1, 3, 4 and 5, and in rebuilding and repairing slope and vertical walls. The plans for this contract have been approved by the Canal Board.

CONTRACT No. 23.

Engineer's estimate.............................. $25,620 00

This contract will include the building of the Brockport, Holley, Brockville and Albion waste-weirs.

CONTRACT No. 24.

Engineer's estimate	$40,000 00

This contract will consist in lowering the Rochester aqueduct.

CONTRACT No. 25.

Engineer's estimate	$200,000 00

This contract will consist in deepening and lengthening locks 57, 58 and 59, at Newark.

CONTRACT No. 26.

Engineer's estimate	$144,290 00

This contract extends from 1,400 feet west of Port Gibson bridge, No. 30, to lock No. 61, a distance of 8.68 miles. The work will consist in deepening the canal to the required depth, in rebuilding the berme abutment of bridge No. 39 and in rebuilding and repairing slope and vertical walls.

CONTRACT No. 27.

Engineer's estimate	$30,000 00

This contract will consist in building five stop-gates.

NOTE.

Contracts Nos. 16 and 22 have been approved by the Canal Board but not let. Contracts Nos. 17, 18, 19, 20, 21, 23, 24, 25, 26 and 27 have not yet been approved.

ESTABLISHMENT OF NEW GRADES AND WATER SURFACES.

With the exceptions noted under the descriptions of contracts Nos. 1, 2, 3 and 5, the new grades and water surfaces have been made to obtain the exact 9 feet of water and have been made

parallel to the old grades and water surfaces. The old canal was 7 feet deep and the improved canal must have 9. To do this the bottom (1) must be deepened 2 feet, (2) the surface of water raised 2 feet or (3) the surface raised and the bottom deepened enough to make 2 feet. From Buffalo to Lockport the canal water surface is practically the same as that of Lake Erie, and so, of necessity, this portion of the canal had to be deepened, it being impossible to raise the water surface. The lower end of the 66½ mile level runs through the city of Rochester. In the city, over the canal, are thirty bridges. To raise the water surface meant to raise these bridges, as well as those situated between Rochester and Lockport. The estimated cost of raising these bridges and repairing the approaches thereto was so large as to make it more economical to leave the water surface as it was. This same argument applied to all of the rest of this division except to the levels (1) between locks Nos. 60 and 61, which will be raised 1 foot and lowered 1 foot, (2) the two levels between locks Nos. 57 and 59, which has been decided upon and (3) between the Wayne county line and lock No. 53, which will be raised 1 foot and lowered 1 foot.

ILLUSTRATIONS.

A large number of illustrations are annexed to this report, since they show better than words can possibly, the conditions of some of the old and new work described in the foregoing pages. The dilapidated condition of old walls and structures shown by these photographs are not in any manner exceptional cases. They are, in fact, characteristic of the entire length of the canals, and it will be apparent to any one who will study them even hastily why it is impossible for any engineer, however expert,

to form any reliable idea as to how much of these walls nor how many of these structures will tumble into the canal when other work in their vicinity is undertaken. This is the chief reason for the variations between the original estimates and the final cost of several of the contracts.

Nearly three-quarters of the entire cost of the present improvement of the Erie, Oswego and Champlain canals is involved in walls and structures that must be built or rebuilt in order to make it possible to complete the deepening as directed by law. The work embraced by this improvement is 454 miles long, and, taking both banks, it is fair to estimate that there exists to-day at least 600 miles of vertical and slope walls, nearly every foot of which must necessarily be undermined to accomplish the deepening. If the walls happen to be in good condition they can be underpinned and saved; if not they must be torn down and rebuilt, or else they will fall down.

The surface appearance of the walls has been found to be no indication of the character of the work back of the face, and in many cases what appeass on the surface to be substantial work has proved to be simply a veneer. In many cases where these walls appear to be substantial, their foundations are so insecure that the work of deepening destroys the whole structure and necessitates its rebuilding. No one can tell to what extent these features will develop until the actual work is started from place to place. However, the contracts provide that the State shall pay only for the quantities of work actually performed, and in some cases these quantities are considerably less than those that have been estimated.

The brief remarks in connection with each plate will serve to indicate the features which the plates are intended to illustrate.

EASTERN DIVISION.

Bullard's Bridge, Champlain Canal.

(No. 9.)

(Chapter 254, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. A. Hendrickson	Leveler	8	$4 50 per day	$36 00	$12 43	$48 43
John A. O'Connor	Draftsman	26	3 50 per day	91 00	3 30	94 30
						$142 73

Ordinary Repairs, Champlain Canal.

(No. 2.)

(Chapter 946, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Dewitt C Smith	Division engineer	....	$3,000 00 per year	$999 96	$123 57	$1,123 53
A. M Evans	Assistant engineer	....	5 00 per day	135 00	....	135 00
C. M Pepson	Rodman	29	3 50 per day	101 50	21 48	122 98
H J. Richardson	Chainman	31	3 50 per day	108 50	....	108 50
George McDonald	Chainman	31	2 50 per day	77 50	....	77 50
Mae F. Gledhill	Stenographer	51	3 00 per day	153 00	....	153 00
John J. Allen	....	350	5 00 per day	1,750 00	154 72	1,904 72
						$3,625 23
Incidental expenses.						
Labor				$40 70		
Postage and telegraph				35 40		
Miscellaneous				42 93	....	119 03
						$3,744 26

Examinations and Maps.

(No 20)

(Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C H. Flanigan	Leveler	108	$5 00 per day	$540 00	$115 91	$655 91
C. H. Flanigan	Leveler	126	4 50 per day	567 00	....	567 00
E. G Blessing	Rodman	10	3 50 per day	35 00	....	35 00
						$1,257 91
Incidental expenses.						
Labor				$1,828 25		
Stationery				42 05		
Miscellaneous				1,716 49	....	3,586 79
						$4,844 70

(No. 10.)

Deepening and Widening between Great South Bay and Shinnecock Bay.

(Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. M. Evans	Assistant engineer	50	$5 00 per day	$50 00	$18 86	$68 86
Guy H. Miller	Leveler	94	4 50 per day	423 00	36 61	459 61
Henry F. Smith	Chainman	84	3 50 per day	294 00	14 88	308 88
						$837 35

Shinnecock and Peconic Canal (Piling and Protecting).

(No. 11.)

(Chapter 791, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Frank Roberts	Rodman	3	$3 50 per day	$10 50	$18 93	$29 43
Incidental expenses.						
Labor				$19 90		
Livery				25 00		
Postage and telegraph				1 03		
Miscellaneous				12 18		58 11
						$87 54

23

No. 21.)

Upper Hudson River Survey.

(Chapter 329, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George W. Rafter	Engineer in charge	8	$10 00 per day	$80 00	$8 69	$88 69
Foster B. Moras	Draftsman	27	5 00 per day	135 00		135 00
Seth Van Loan	Rodman	27	3 50 per day	94 50		94 50
Parkes D. Wendell	Chainman	27	2 50 per day	67 50		67 50
						$385 69
Incidental expenses.						
Labor				$67 50		
Miscellaneous				1,426 90		1,494 40
						$1,880 09

Extraordinary Repairs — Erie and Champlain Canals.

(No. 13.)

(Chapters 947 and 566, Laws of 1896, 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. M. Evans	Assistant engineer	104	$5 00 per day	$520 00	....	$520 00
Wallace Greenalch	Assistant engineer	54	5 00 per day	270 00	$4 64	274 64
F. A. Bagg	Assistant engineer	53	5 00 per day	265 00	21 26	286 26
Dorlon Clark	Leveler	103	4 50 per day	463 50	37 91	501 41
W. W. Olney	Leveler	45	4 50 per day	202 50	5 58	208 08
T. A. Hendrickson	Leveler	212	4 50 per day	954 00	227 68	1,181 68
L. B. Jones	Leveler	267	4 50 per day	1,201 50	94 36	1,295 86
Foster B. Morss	Draftsman	272	5 00 per day	1,360 00	189 98	1,549 98
C. D. Burrus	Draftsman	50	4 50 per day	225 00	....	225 00
Seth Van Loan	Rodman	102	3 50 per day	357 00	13 38	370 38
Parkes D. Wendell	Chainman	103	2 50 per day	257 50	28 94	286 44
William Van Epps	Chainman	91	3 00 per day	273 00	29 58	302 58
L. L. Melius	Chainman	75	2 50 per day	197 50	21 46	218 96
L. Dedrick	Chainman	11	2 50 per day	27 50	11 29	38 79
W. B. Strong	Chainman	53	2 50 per day	132 50	3 00	135 50
George McDonald	Chainman	115	2 50 per day	292 50	4 30	296 80
Frank Kromer	Chainman	17	2 50 per day	42 50	5 83	48 33
A. F. Piau	Chainman	17	2 50 per day	42 50	5 45	47 95
Perry Filkins	Rodman	51	3 50 per day	199 50	13 37	212 87
						$8,001 51
Incidental expenses.						
Office rent				$88 00		
Livery				177 00		
Labor				185 50		
Miscellaneous				828 08		1,278 58
						$9,280 09

Lengthening Locks 21 and 22, Erie Canal.

(No. 12.)

(Chapters 79 and 320, Laws of 1895; Chapter 794 Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. C. Huestis	Assistant engineer	224	$5 00 per day	$1,120 00	$224 66	$1,344 66
F. J. Lempe	Leveler	224	4 50 per day	1,008 00	31 44	1,039 44
E. G. Blessing	Rodman	27	3 50 per day	94 50	16 65	111 15
Perry Filkin	"	194	3 50 per day	679 00	4 33	683 33
R. S. Greenman	"	102	3 50 per day	357 00	....	357 00
Frank Lutz	Chainman	199	3 00 per day	597 00	5 30	602 30
Ralph Russell	"	191	3 50 per day	668 50	45 64	714 14
William Van Epps	"	53	2 50 per day	142 50	2 34	144 84
William Van Epps	"	55	3 00 per day	165 00	....	165 00
L. Dedrick	"	27	2 50 per day	67 50	15 41	82 91
W. E. Petty	"	198	2 50 per day	495 00	13 24	508 24
Henry F. Smith	"	118	3 50 per day	413 00	4 40	417 40
						$6,170 41
Incidental expenses.						
Office rent					$67 25	
Fuel and light					15 16	
Postage and telegraph					7 07	
Labor					6 35	
Miscellaneous					21 40	
						117 23
						$6,287 64

Bridge over the Glens Falls Feeder at Glen Street, Glens Falls, N. Y.

(No. 7.)

(Chapter 798, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. A. Hendrickson	Leveler	16	$4 50 per day	$72 00	$23 72	$95 72
William Van Epps	Chainman	2	3 00 per day	6 00	7 23	13 23
						$108 95
Incidental expenses.						
Office rent				$8 00		
Fuel and light				3 25		
Miscellaneous				144 55		
						155 80
						$264 75

(No. 8.)

Repairs to Rexford's Flats dam.

(Chapters 560, 947 and 566, Laws of 1895, 1896, 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. C. Huestis	Assistant engineer	26	$5 00 per day	$130 00	$7 30	$137 30
F. J. Lempe	Leveler	27	4 50 per day	121 50	2 60	124 10
W. E. Petty	Chainman	27	2 50 per day	67 50	....	67 50
						$328 90

Culvert over Weigh Lock Outlet at Waterford.

(No. 6.)

(Chapter 364, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John J. Tait	Assistant engineer	16	$5 00 per day	$80 00	$24 20	$104 20
M. W. Brown	Leveler	24	4 50 per day	108 00	9 75	117 75
C. D. Burrus	Draftsman	26	4 50 per day	117 00	....	117 00
R. M. Booth	Chainman	27	2 50 per day	67 50	10 00	77 50
						$416 45

Railroad Street Lift Bridge, Ilion.

(No. 18.)

(Chapter 105, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Ralph Russell	Chainman	6	$3 50 per day	$21 00	$8 57	$29 57
Ralph Russell	Chainman	27	4 50 per day	121 50	20 68	142 18
L. L Melius	Chainman	34	2 50 per day	85 00	9 73	94 73
George P. Hilton	Draughtsman	....	....	331 85	....	331 85
						$597 83

Approaches, etc., to Maple Street Bridge, Sandy Hill.

(No. 5.)

(Chapter 286, Laws of 1895, and Chapter 975, Laws of 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. A. Hendrickson	Leveler	18	$4 50 per day	$81 00	$11 67	$92 67

(No. 19)

Special Surveys, State Board of Claims.

(Chapter 790, Laws of 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
T. C. Leutze	First assistant engineer	248	$6 00 per day	$1,488 00	$1,720 02	$3,208 02
M. P. Quintana	Assistant engineer	52	5 00 per day	260 00	4 46	264 46
C. E. Phelps	Assistant engineer	81	5 00 per day	405 00	67 87	472 87
Dorlon Clark	Leveler	99	4 50 per day	445 50	218 87	664 37
F. S. Strong	Leveler	159	4 50 per day	715 50	562 62	1,278 12
W. W. Olney	Leveler	67	4 50 per day	301 50	9 82	311 32
Frank Roberts	Rodman	109	3 50 per day	381 50	251 79	633 29
James K. Browne	Rodman	70	3 50 per day	245 00	4 46	249 46
Frank Lutz	Chainman	103	3 00 per day	309 00	215 46	524 46
Ralph Russell	Chainman	102	3 50 per day	357 00	315 59	672 59
H. J. Richardson	Chainman	94	3 50 per day	329 00	236 45	565 45
William Van Epps	Chainman	28	2 50 per day	70 00	50 67	120 67
William Van Epps	Chainman	80	3 00 per day	240 00	223 21	463 21
James T. Brady	Chainman	65	2 50 per day	167 50	10 48	177 98
L. L. Melius	Chainman	46	2 50 per day	115 00	13 09	128 09
H. M. Booth	Chainman	70	2 50 per day	175 00	9 44	184 44
George Kirk, Jr.	Chainman	34	2 50 per day	85 00	4 23	89 23
R. M. Booth	Chainman	26	2 50 per day	65 00	7 51	72 51
J. J. Allen		7	5 00 per day	35 00	38 46	73 46
						$10,154 00
Incidental expenses.						
Labor					$1,389 87	
Livery					140 50	
Postage and telegraph					157 81	
Miscellaneous					1,122 72	
						2,810 90
						$12,964 90

Statement showing names, rank, number of days and compensation of engineers employed on the Eastern Division of the New York State Canals, together with incidental expenses during the fiscal year ending September 30, 1897.

(No. 1.) (Ordinary Repairs, Erie Canal, Chapter 946, Laws 1896.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Dewitt C. Smith	Division engineer	....	$3,000 00 per year	$2,000 04	$467 13	$2,467 17
Albert J. Himes	Resident engineer	....	2,400 00 per year	13 14	21 11	34 25
George W. Rafter	Engineer in charge	33	10 00 per day	330 00	18 69	348 69
F. A. Bagg	Assistant engineer	43	5 00 per day	215 00	26 78	241 78
T. A. Hendrickson	Leveler	11	4 50 per day	49 50	38 34	87 84
John A. O'Conner	Draftsman	28	3 50 per day	98 00	....	98 00
C. M. Pepson	Rodman	332	3 50 per day	1,162 00	79 92	1,241 92
Frank Roberts	Rodman	29	3 50 per day	101 50	....	101 50
Henry F. Smith	Chainman	28	3 50 per day	98 00	3 40	101 40
Eugene H. Lilly	Chainman	179	3 50 per day	626 50	1 25	627 75
H. J. Richardson	Chainman	26	3 50 per day	91 00	3 08	94 08
George McDonald	Chainman	59	2 50 per day	147 50	2 35	149 85
Mae F. Gledhill	Stenographer	185	3 00 per day	555 00	....	555 00
	Incidental expenses.					$6,149 23
Labor					$188 26	
Postage and telegraph					96 81	
Miscellaneous					1,053 69	
Stationery					50 25	
						1,389 01
						$7,538 24

Topographical Survey.

(No. 22.) (Chapter 391, Laws of 1897.)

NAME.	Travel.
William J. Peters	$2,050 41
J. H. Jennings	2,202 98
George M. Taylor	142 50
F. S. Wills	40 57
Frank Sutton	1,683 81
F. D. Pierce	41 37
R. D. Cummin	645 54
C. P. De Witt	126 50
E. B. Clark	766 16
C. C. Bassett	218 05
W. H. Lovell	1,605 49
H. S. Swartwell	28 00
Will Osborne	274 31
W. M. Beaman	1,163 85
A. M. Walker	1,111 22
S. S. Gammett	98 41
E. L. McNair	15 80
Gaston P. Phillips	22 58
Clarence F. Horton	19 26
R. Guy Foster	22 58
A. Maldemar	12 90
A. H. Bumstead	16 18
Clark Brown	29 35
Robert Menzie	47 50
J. W. Thom	438 84
L. T. Haney	16 18
J. M. Slayton	218 12
Hiram Porter	18 00
J. H. Wheat	45 95
F. N. Parrish	33 50
H. G. Locke	374 63
A. A. Fuller	32 00
C. A. Petrie	58 65
M. M. Lucid	33 24
Bion H. Kemp	130 69
C. M. Barrett	85 70
S. Stephens	12 00
John King	33 00
Isaiah Perkins	100 56
Total	$14,000 78

(No. 14.)

Improvement Erie Canal.

(Chapters 79, 794, 43 and 569, Laws of 1895, 1896, 1897.)

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,400 00 per year	$1,216 42	$389 93	$1,606 35
T. C. Leutse	First assistant engineer	117	6 00 per day	702 00	443 51	1,145 51
A. M. Evans	Assistant engineer	151	5 00 per day	755 00	26 65	781 65
W. L Lawton	" "	320	5 00 per day	1,600 00	136 83	1,736 83
C. W. Trumbull	" "	319	5 00 per day	1,595 00	166 35	1,761 35
M H. Ranney	" "	327	5 00 per day	1,635 00	346 39	1,981 39
F A. Bagg	" "	223	5 00 per day	1,115 00	85 50	1,200 50
Wallace Greenalch	" "	104	5 00 per day	520 00	26 65	546 65
C. C. Huestis	" "	79	5 00 per day	395 00	57 15	452 15
F. N. Sanders	Leveler	52	4 50 per day	234 00	27 49	261 49
H. P. Willis	"	318	4 50 per day	1,431 00	91 85	1,522 85
F. E. Spinner	"	325	4 50 per day	1,462 50	179 78	1,642 28
Douglas Cornell	"	325	4 50 per day	1,462 50	153 25	1,615 75
Dorlon Clark	"	122	4 50 per day	549 00	36 93	585 93
F. S. Strong	"	181	4 50 per day	814 50	90 42	904 92
James Burden	"	176	4 50 per day	792 00	10 59	802 59
T. A. Hendrickson	"	13	4 50 per day	58 50	5 89	64 39
L. B. Sebring	"	62	4 50 per day	279 00	2 61	281 61
Guy H. Miller	"	79	4 50 per day	355 50	5 28	360 78
F. J Lempe	"	79	4 50 per day	355 50	9 20	364 70
M. W. Brown	"	21	4 50 per day	94 50	2 20	96 70
C. D. Burrus	Draftsman	210	4 50 per day	945 00	5 39	950 39
George L. Schillner	"	303	4 50 per day	1,363 50	8 50	1,372 00
George P. Hilton	"	....	....	1,611 90	....	1,611 90
H. W. De Graff	Rodman	326	3 50 per day	1,141 00	16 77	1,157 77
Alexander Haring	"	322	3 50 per day	1,127 00	....	1,127 00
O. J. Dempster	"	318	3 50 per day	1,113 00	....	1,113 00
Fred. Edwards	"	314	3 50 per day	1,099 00	21 12	1,120 12
Frank Roberts	"	159	3 50 per day	556 50	22 63	579 13
C. M. Pepson	"	30	3 50 per day	105 00	....	105 00
E. G. Blessing	"	285	3 50 per day	997 50	28 65	1,026 15
Perry Filkins	"	53	3 50 per day	185 50	....	185 50
L. Potter	Chainman	314	3 50 per day	785 00	32 57	817 57
John Weeks	"	317	2 50 per day	792 50	26 39	818 89
Frank Kromer	"	299	2 50 per day	747 50	32 77	780 27
A. F Pfau	"	310	2 50 per day	775 00	42 74	817 74
J. L Yates	"	287	2 50 per day	717 50	20 05	737 55

Frank Bartlett	"		318	2 50 per day	795 00	30 97	825 97
J. B. Tiffany	"		318	2 50 per day	795 00	70 51	865 51
J. G. Stewart	"		318	2 50 per day	795 00	68 80	863 80
C. J. Reardon	"		321	2 50 per day	802 50	....	802 50
George Kirk, Jr	"		286	2 50 per day	715 00	4 80	719 80
W. H. H Klinkhart	"		142	2 50 per day	355 00	20 15	375 15
George H. Moulthrop	"		52	2 50 per day	130 00	....	130 00
C. R. Conklin	"		13	2 50 per day	32 50	....	32 50
James T Brady	"		248	2 50 per day	620 00	39 19	659 19
W. J Gilmore	"		52	3 50 per day	182 00	22 48	204 48
George McDonald	"		59	2 50 per day	147 50	3 33	150 83
L. Dedrick	"		287	2 50 per day	717 50	76 69	794 19
Henry F. Smith	"		103	3 50 per day	360 50	9 29	369 79
Henry J. Richardson	"		172	3 50 per day	602 00	49 10	651 10
Mathew O'Connor	"		84	2 50 per day	210 00	9 57	219 57
James Lyons	"		104	2 50 per day	260 00	4 09	264 09
H C. Titus	"		235	2 50 per day	587 50	4 57	592 07
H. M. Booth	"		100	2 50 per day	250 00	....	250 00
L. L. Melius	"		27	2 50 per day	67 50	70	68 20
Parkes D. Wendell	"		162	2 50 per day	405 00	6 29	411 29
William Van Epps	"		23	3 00 per day	69 00	5 02	74 02
Frank Luts	"		33	3 00 per day	99 00	1 09	100 09
W. E. Petty	"		79	2 50 per day	197 50	....	197 50
							$43,657 49

Incidental expenses.

Office rent	$656 20		
Fuel and light	28 05		
Livery	5,191 35		
Labor	2,279 35		
Postage and telegraph	315 96		
Stationery	1,591 59		
Dutton Pneumatic Lock and Engineering Co	2,500 00		
Miscellaneous	1,472 27		
		....	14,034 77
			$57,692 26

Improvement Champlain Canal.

(No. 15.)

(Chapters 79, 794, 43 and 569, Laws of 1895, 1896, 1897.)

NAME.	Rank.		Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer		$2,400 00 per year	$1,170 44	$253 55	$1,423 99
John R. Kaley	First assistant engineer	239	6 00 per day	1,434 00	193 05	1,627 05
John G. Tait	Assistant engineer	297	5 00 per day	1,485 00	222 45	1,707 45
Monroe Warner	" "	315	5 00 per day	1,575 00	522 31	2,097 31
M. P. Quintana	" "	262	5 00 per day	1,310 00	60 97	1,370 97
F. N. Sanders	Leveler	284	4 50 per day	1,278 00	61 26	1,339 26
T. A. Hendrickson	"	57	4 50 per day	256 50	31 38	287 88
M. W. Brown	"	233	4 50 per day	1,048 50	35 95	1,084 45
C. H. Nichols	"	106	4 50 per day	477 00	8 20	485 20
W. W. Olney	"	202	4 50 per day	909 00	27 76	936 76
L. B. Jones	"	52	4 50 per day	234 00	8 83	242 83
George P. Hilton	Draftsman			38 39		38 39
John A. O'Connor	"	133	3 50 per day	465 50	41 15	506 65
C. D. Burrus	"	27	4 50 per day	121 50		121 50
Perry Filkins	Rodman	27	3 50 per day	94 50		94 50
Frank Roberts	"	24	3 50 per day	84 00	12 79	96 79
W. S. Jones	"	340	3 50 per day	11 90	32 54	1,222 64
C. H. Nichols	"	209	3 50 per day	731 50	26 92	758 42
Seth Van Loan	"	187	3 50 per day	654 50	4 74	659 24
George H. Moulthrop	Chainman	274	2 50 per day	685 00		685 00
C. A. Conklin	"	136	2 50 per day	340 00		340 00
William J. Gilmore	"	262	3 50 per day	917 00	56 60	973 60
George McDonald	"	90	2 50 per day	225 00	12 78	237 78
H. J. Richardson	"	15	3 50 per day	52 50	6 45	58 95
L. L. Melius	"	24	2 50 per day	60 00	7 72	67 72
Parkes D. Wendell	"	31	2 50 per day	77 50	5 76	83 26
W. E. Petty	"	27	2 50 per day	67 50		67 50
H. S. Miller	"	342	2 50 per day	855 00	143 80	998 80
P. H. Ryan	"	131	2 50 per day	327 50	7 74	335 24
Jesse Patrick	"	319	2 50 per day	797 50	20 59	818 09
F. G. Tilton	"	313	2 50 per day	782 50	18 58	801 08
R. M. Booth	"	286	2 50 per day	715 00	17 45	732 45
John A. O'Connor	"	78	2 50 per day	195 00	12 89	207 89
F. H. Owens	"	250	2 50 per day	625 00	13 05	638 05
A. S. McMurray	"	250	2 50 per day	625 00	2 19	627 19
B. Toner	"	105	2 50 per day	262 50	7 40	269 90

W. B. Strong	"		274	2 50 per day	685 00	8 85	693 85
W. B. Ingalsbe	"		228	2 50 per day	570 00	29 58	599 58
A. W. Foster	"		35	2 50 per day	87 50	4 55	92 05
							$25,429 15

Incidental expenses.

Office rent	$303 70		
Stationery	768 16		
Fuel and light	50 63		
Postage and telegraph	156 73		
Livery	2,583 00		
Labor	594 16		
Miscellaneous	716 64		
			5,172 96
			$30,602 11

The foregoing tables are summarized as follows:

No.			
	Ordinary Repairs.		
No. 1.	Erie canal, chapter 946, Laws of 1896	$7,538 24	
2.	Champlain canal, chapter 946, Laws of 1896	3,744 26	
			$11,282 50
	Extraordinary Repairs.		
3.	wall, chapte[illegible]	$131 90	
4.	y bridge, cha[illegible]	130 00	
5.	street bridg[illegible] 75, Laws of 1896	92 67	
6.	outlet, Wate[illegible]	416 45	
7.	feeder, Glen [illegible]	264 75	
8.	ate dam, chap[illegible] chapters 566 and 572, Laws of 1897	328 90	
9.	ain canal, ch[illegible]	142 73	
10.	[illegible] between Gr[illegible] of 1896, and chapter 790, Laws of 1897	637 35	
11.	Shinnecock and Peconic canal (piling [illegible] r 791, Laws of 1897	87 54	
12.	Lengthening locks 21 and 22 Erie can[illegible] s of 1896	6,287 64	
13.	Extr[illegible] Laws of 1897	9,280 09	
14.	Impr[illegible] 3 and 569, Laws of 1897	57,692 26	
15.	Impr[illegible] pter 794, Laws of 1896, and chapters 43 and 569, Laws of 1897	30,602 11	
16.	Rive[illegible]	211 68	
17.	Four[illegible]	46 50	
18.	Rail[illegible]	597 53	
			107,150 40
	Special Surveys.		
19.	Making surveys and maps for use of the State Board of Claims, chapter 950, Laws of 1896, and chapter 790, Laws of 1897	$12,964 90	
20.	Making surveys and maps required by State Engineer and Surveyor, chapter 950, Laws of 1896, and chapter 790, Laws of 1897	4,844 79	
21.	Upper Hudson river survey, chapter 220, Laws of 1896	1,680 09	
22.	Topographical survey New York State, chapter 490, Laws of 1896, and chapter 891, Laws of 1897	14,090 73	
			33,690 43
			$152,123 33

Table of Contracts on Eastern Division Completed During the Year Ending September 30.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation	Legislative Act. Chapter.	Legislative Act. Year.	Engineer's estimate at contract prices.	Final estimate.
		Erie Canal.					
Hilton Bridge Construction Co.	March 1, 1897	A steel bridge over the Erie canal at the junction of the Erie and Champlain canals, and preparing old abutments to receive same	$125,000	947	1896	$6,754 75	$7,378 00
Chambers & Casey	Sept. 7, 1896	Lengthening locks 21 and 22, Erie canal, and for other work incident thereto	87,500	79, 320 794	1895 1896	96,303 90	118,239 73
John V. Quackenbush	Nov. 10, 1896	For the improvement of the eastern division of the Erie canal from lock 44 to lock 45, a distance of 1 24 miles	9,000,000	79 794 43, 569	1895 1896 1897	38,749 30	45,315 35
John V. Quackenbush	Nov. 11, 1896	For the improvement of the eastern division of the Erie canal from lock 42 to lock 44, a distance of 2.90 miles	9,000,000	79 794 43, 569	1895 1896 1897	113,436 66	141,591 14
Jeremiah Adams	Oct. 11, 1895 Sept. 10, 1896	Extending wall … the berme and raising th… the Maple Street bridge, … erstructure and raising the approaches, etc.	10,000 1,500	286 796	1895 1896	7,348 60 1,180 12	9,026 70
Cunningham & Monty	Oct. 5, 1896	Repairing steel dam across Mohawk river at Cohoes.	125,000	947	1896	11,710 00	11,609 00
Michael Bennett	Sept. 5, 1896	A stone arch culvert over the weigh lock outlet at Second street, and for outlet walls between Second street and the Hudson river, on the Champlain canal, at Waterford, N. Y.	5,000	364	1896	3,041 75	3,365 08
Cunningham & Monty	June 10, 1897	An iron bridge on the Champlain canal at the Bul- … county	4,000	254	1896	3,400 70	4,017 55
Hilton Bridge Construction Co.	Feb. 11, 1897	… Glen street,	5,000	796	1896	4,057 50	4,302 28
John J. Cunningham	Sept. 26, 1896	…plain canal	125,000	947	1896	27,447 00	25,453 31
Jeremiah Adams	Mar. 15, 1897	To rebuild waste weir over Glens Falls feeder near the Glens Falls Co.'s lime kilns	125,000	947	1896	2,830 70	3,073 00
Hilton Bridge Construction Co.	April 9, 1897	A steel bridge superstructure (Wilson's road bridge), Champlain canal	125,000	947	1896	660 00	668 00
Hilton Bridge Construction Co.	April 9, 1897	An iron bridge superstructure between locks 15 and 16, Champlain canal	125,000	947	1896	630 00	650 00

Table of Contracts on Eastern Division Completed During the Year Ending September 30—(Concluded).

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act.		Engineer's estimate at contract prices.	Final estimate.
				Chapter.	Year.		
		Champlain Canal—(Continued).					
Whalen & Higgins	Nov. 14, 1896	For the improvement of the Champlain canal from a point about 200 feet south of Waterford sidecut to lock 5, a distance of 1.3 miles	$9,000 000	79 794 43, 569	1895 1896 1897	$58,376 00	$89,940 41
J. W. Whalen	Nov. 10, 1896	For the improvement of the Champlain canal from lock 6 to lock 7, a distance of 3.0 miles	9,000,000	79 791 43, 569	1895 1896 1897	92,296 00	116,634 00
		Miscellaneous.					
James J. Dwyer	Aug. 18, 1896	For a concrete coping on sea wall between East Marion and Orient	15,000 1,000	838 950	1895 1896	1,700 00	2,051 00
P. J. Brummelkamp	Oct. 23, 1895	For piling and protecting the banks of the Shinnecock and Peconic canal	12,800 5,000	932 950	1895 1896	10,671 50 4,000 00	13,348 04

Table of Contracts Pending on the Eastern Division September 30.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chapter.	Legislative Act. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract prices.	Payments to date.
		Erie Canal.						
J. W. Whalen	Nov. 10, 1896	For the improvement of the eastern division of the Erie canal, from lock 20 to lock 21, a distance of 3.32 miles	$9,000,000 00	79 794 43, 569	1895 1896 1897	$57,488 00	$52,910 50	$10,200 00
Lauer & Hageman	Nov. 17, 1896	For the improvement of the eastern division of the Erie canal from lock 27 to lock 28, a distance of 5.21 miles	9,000,000 00	79 794 43, 569	1895 1896 1897	75,028 00	74,109 35	70,064 00
Gallo & McNeice	Nov. 9, 1896	For the improvement of the eastern division of the Erie canal from lock 28 to lock 29, a distance of 1.97 miles	9,000,000 00	79 794 43, 569	1895 1896 1897	33,261 00	31,590 06	22,592 00
Brummelkamp, Lane & Co.	Nov 16, 1896	For the improvement of the eastern division of the Erie canal from lock 32 to lock 33, a distance of 5.11 miles	9,000,000 00	79 794 43, 569	1895 1896 1897	90,533 65	88,484 35	72,549 00
Lauer & Hageman	Nov. 17, 1896	For the improvement of the eastern division of the Erie canal from lock 33 to lock 34, a distance of 2.57 miles	9,000,000 00	79 794 43, 569	1895 1896 1897	46,060 00	42,881 25	41,068 00
Shear & Haight	Nov. 11, 1896	For the improvement of the eastern division of the Erie canal from lock 22 to bridge 53, a distance of 3.20 miles	9,000,000 00	79 794 43, 569	1895 1896 1897	84,740 00	79,320 50	63,846 60
Thomas H. Karr	Sept. 28, 1897	For the improvement of the eastern division of the Erie canal from lock 29 to lock 30, a distance of 0.67 mile	9,000,000 00	79 794 43, 569	1895 1896 1897	9,077 00	9,122 50	....
John V. Quackenbush	Sept. 21, 1897	For the improvement of the eastern division of the Erie canal from lock 45 to the east line of Oneida county, a distance of 6.77 miles	9,000,000 00	79 794 43 569	1895 1896 1897 1897	225,326 00	181,996 00	....
Thomas H. Karr	Sept. 28, 1897	For the improvement of the eastern divi- [illegible] to lock [illegible]	9,000,000 00	79 794 43, 569	1895 1896 1897	71,978 00	65,812 00	....
Troy Public Works Co	Sept. 16, 1897	Fo[illegible] divi [illegible] to lock [illegible]	9,000,000 00	79 794 43, 569	1895 1896 1897	140,220 00	132,678 00	....
Clinton Beckwith	Sept. 21, 1897	Fo[illegible] divi- [illegible] to lock [illegible]	9,000,000 00	79 794 43, 569	1895 1896 1897	65,206 50	63,000 00	....

Table of Contracts on Eastern Division Completed During the Year Ending September 30—(Concluded).

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chapter.	Legislative Act. Year.	Engineer's estimate at contract prices.	Final estimate.
		Champlain Canal—(Continued).					
Whalen & Higgins	Nov. 14, 1896	For the improvement of the Champlain canal from a point about 200 feet south of Waterford sidecut to lock 5, a distance of 1.3 miles	$9,000 000	79 794 48, 569	1895 1896 1897	$58,376 00	$89,940 41
J. W. Whalen	Nov. 10, 1896	For the improvement of the Champlain canal from lock 6 to lock 7, a distance of 3.0 miles	9,000,000	79 794 43, 569	1895 1896 1897	92,296 00	116,634 00
		Miscellaneous.					
James J. Dwyer	Aug. 18, 1896	For a concrete coping on sea wall between East Marion and Orient	15,000 1,000	838 950	1895 1896	1,700 00	2,051 00
P. J. Brummelkamp	Oct. 23, 1895	For piling and protecting the banks of the Shinnecock and Peconic canal	12,800 5,000	932 950	1895 1896	10,671 50 4,000 00	13,348 04

Table of Contracts Pending on the Eastern Division September 30.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chapter.	Legislative Act. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract prices.	Payments to date.
		Erie Canal.						
J. W. Whalen	Nov. 10, 1896	For the improvement of the eastern division of the Erie canal, from lock 20 to lock 21, a distance of 3.22 miles	$9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	$57,668 00	$52,010 50	$19,200 00
Lauer & Hagaman	Nov. 17, 1896	For the improvement of the eastern division of the Erie canal from lock 27 to lock 28, a distance of 6.21 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	75,028 00	74,150 85	78,064 00
Gallo & McNeice	Nov. 9, 1896	For the improvement of the eastern division of the Erie canal from lock 28 to lock 29, a distance of 1.97 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	33,251 00	31,590 05	23,382 00
Brummelkamp, Lane & Co	Nov 16, 1896	For the improvement of the eastern division of the Erie canal from lock 32 to lock 33, a distance of 5.11 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	90,532 65	88,434 35	72,540 00
Lauer & Hagaman	Nov. 17, 1896	For the improvement of the eastern division of the Erie canal from lock 33 to lock 34, a distance of 2.57 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	45,080 00	43,831 25	41,688 00
Shear & Haight	Nov. 11, 1896	For the improvement of the eastern division c[illegible] from lock 22 to bridge [illegible] 3.29 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	84,740 00	79,320 50	63,846 00
Thomas H. Karr	Sept. 23, 1897	For the [illegible] the eastern division o[illegible] from lock 29 to lock 30, a distance of 0.67 mile	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	9,677 00	9,122 50	....
John V. Quackenbush	Sept. 21, 1897	For the improvement of the eastern division of the Erie canal from lock 45 to the east line of Oneida county, a distance of 6.77 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897, 1897	235,835 00	181,098 00	....
Thomas H Karr	Sept. 23, 1897	For the improvement of the eastern division of the Erie canal from lock 19 to lock 20, a distance of 2.71 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	71,073 00	65,812 00	....
Troy Public Works Co	Sept. 16, 1897	For the improvement of the eastern division of the Erie canal from lock 25 to lock 27, a distance of 6.59 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	140,280 00	132,078 00	....
Clinton Beckwith	Sept. 21, 1897	For the improvement of the eastern division of the Erie canal from lock 40 to lock 41, a distance of 2.64 miles	9,000,000 00	79, 794, 43, 569	1895, 1896, 1897	58,208 50	53,000 00	....

Table of Contracts Pending on the Eastern Division September 30—(Concluded).

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chapter.	Legislative Act. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract prices.	Payments to date.
		Erie Canal—(Continued).						
John V. Quackenbush	Sept. 21, 1897	For [illegible] n divi- [illegible] to lock 42 [illegible]	9,000,000 00	79 794 43, 569	1895 1896 1897	$75,450 50	$59,290 50	....
Clinton Beckwith	Sept. 21, 1897	For [illegible] n division of the Erie canal from lock 39 to lock 40, a distance of 2.76 miles	9,000,000 00	79 749 43, 569	1895 1896 1897	84,489 00	66,529 00	....
Whalen & Higgins	Sept. 14, 1897	For rebuilding apron and repairing dam across the Mohawk river at Rexford's Flats	20,000 00 125,000 00 *13,149 48	560 947 566 972	1895 1896 1897 1897	30,218 00	25,961 50	64,294 [illegible]
Hilton Bridge Construction Co.	July 26, 1897	For a lift bridge at Railroad street, Ilion, N. Y.	18,000 00	105	1897	15,889 00	12,878 20	....
		Champlain Canal.						
Mahan & Sundstrom	Nov. 13, 1896	For the improvement of the Champlain canal between lock 15 and lock 16, a distance of 11.75 miles	9,000,000 00	79 794 43, 569	1895 1896 1897	245,188 76	214,317 53	90,936 00
Havana Bridge Works	Sept. 30, 1897	For a steel bridge over the side cut of the Champlain canal, at the foot of Fourth street, Waterford, N. Y.	4,000 00	575	1897	3,431 75	3,506 75	....
		Miscellaneous.						
William Coats	Aug. 31, 1897	For building a dam across the Racquette river, near Raymondeville, St. Lawrence county, N. Y.	2,000 00	158	1896	1,878 00	1,817 50	1,120 00
Oscar F. Hill	April 30, 1897	For improvements to the Drakedraw bridge [illegible]ok, near New Ham[illegible]ty, N. Y.	1,500 00	949	1896	1,195 50	1,350 00	901 00
P. J. Brummelkamp	Dec. 7, 1896	[illegible] d widening of the canal leading from Shinnecock to Great South Bay, Town of Southampton, County of Suffolk, N. Y.	5,000 00	348	1896	4,220 00	4,220 [illegible]	6,766 00

* Unexpended balance.

APPENDIX.

REPORT ON CONCRETE TESTS

BY

GEORGE W. RAFTER.

Report on Concrete Tests.

ROCHESTER, N. Y., *July* 1, 1898.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Sir.—The undersigned herewith submits a report on the tests of concrete blocks, as per your letter of December 31, 1897.

In my report to you on the Genesee Storage Project, made under date of April 1, 1894, and to be found in the Annual Report of the State Engineer and Surveyor for the fiscal year ending September 30, 1894, there appears a report on the series of concrete blocks fabricated at Mount Morris in the fall of 1893. The tests there recorded show the value of the following natural cements manufactured in this State for use in concrete, namely: Cummings' Buffalo, Newman's Akron, Bangs & Gaynor's Fayetteville, and Norton's Rosendale; also Millem's Wayland Portland, and Saylor's Portland, were experimented with extensively. The record of these tests may be found in the place cited, and it is unnecessary to especially refer to the results at this time. It is sufficient to say that a study of the results raised a large number of questions in regard to concrete, which it seemed desirable to further experiment upon by way of finding solutions of the said questions. In order to obtain immediate results, the concrete blocks fabricated in 1893 were broken within about 90 days. In making a second series of tests, it seemed desirable, however, to allow the blocks to attain considerable age before breaking, and accordingly the present series has been allowed to attain an

age of about 600 days before breaking. The exact age of each block may be determined from Column (4) of Table No. 1.

The blocks here reported upon were fabricated at Mount Morris from July 10, 1896, to September 5, of that year, the specific dates for each block being shown by Column (2) of Table No. 1. The dates of breaking are shown by Column (3) in the same table. The object of these tests wás to obtain more complete information with reference to the possible use of large quantities of concrete in the construction of the Mount Morris dam. In order to make the tests as valuable as possible to the whole State, I have included tests of all the Portland cements manufactured in this State in 1896, namely: Millem's Wayland brand, the Genesee brand, Empire brand, Iron-Clad brand, and the Champion Sand-Silica cement, the latter being an adulterated Portland cement. As shown by Table No. 1, a few tests have also been made of the so-called Buffalo Portland, which is merely selected clinker from the natural Buffalo, as well as a few tests of the natural Buffalo itself. It was not proposed, however, in the present report, to devote any large amount of time to the natural cements, those cements having been quite thoroughly covered by the experiments of 1893, already referred to.

In carrying out the series of tests here reported upon, the leading ideas were: (1) to determine the strength of concretes fabricated with either dry, plastic, or mortars with an excess of water; (2) to determine the effect of various treatments of the concrete with reference to exposure to the weather; and (3) to determine by comparison the relative value of the several Portland cements manufactured in the State of New York, for use in concrete.

The stone used as aggregate in all these tests was of the Portage group, and taken from the ledges near Portageville, either

in the immediate vicinity of the proposed dam, or at the quarry of the Genesee Valley Blue Stone Company near Portageville. This aggregate material was hand-broken to pass through a two-inch ring.

It has been known for a long time that in gaging cements, dry-mixed cements were stronger than wet-mixed. Evidently the effect on concrete is not so well understood, as claims are constantly made of the superiority of quaking concrete—or that in which water is used to excess—over that fabricated with a smaller quantity of water. Undoubtedly, such concrete can be thoroughly compacted with less ramming than can that in which only just enough water has been used to make the mortar moist, but, as shown quite clearly by the present tests, if the mortar is made dry and the concrete thoroughly rammed, a considerable additional strength may be obtained. It should not be overlooked, however, that, in the fabrication of dry concretes, it is absolutely necessary in warm weather, that the surface be kept constantly wet with water, and for the best results, it should also be covered, the best method of accomplishing this being, probably, by the use of large pieces of canvas. This, however, will require some additional labor, and as a commercial question, purely, it will be necessary to decide in each individual case whether the gain in strength is worth the additional labor.

It is frequently urged as a reason for the use of concrete, that the labor may be done by unskilled workmen, that it is all common labor, in short. While this may be true as to the labor of manipulation, ramming, etc., it is, nevertheless, certain that the successful use of concrete under the various conditions of actual practice, requires that the man in charge be of a high degree of intelligence, and thoroughly versed as to the possibilities of the

material, under all possible climatic conditions. It is clear, if one would secure the best results in the use of concrete, that everything like thumb rule methods should be avoided. It is from this point of view that a series of experiments like the one now under consideration is of the greatest value. It enables a studious person to become thoroughly familiar with the capabilities of the material.

Returning to the consideration of dry concretes versus those mixed with an excess of water, it may be remarked that my practical experience on work, taken in conjunction with the result of these experiments, has taught me that the only way in which dry concrete can be safely used on work is to wet the surface thoroughly as soon as the ramming has been completed, and to keep the surface thoroughly wet until after the completion of the setting.

As to the quantity of water to be used, opinions vary. Different writers mention quantities of water of from 9 pounds to 40 pounds per cubic foot. In the present tests an attempt was made to determine the proper weight of water practically by means of judgment as to the consistency of the mortar in each case. As will be noticed by inspecting Table No. 1, the blocks were made in series of four. Those designated by the Arabic numerals only were placed in water when taken from the molds, and allowed to remain until December 1, 1896, when they were buried in sand, where they remained until taken out for shipment, January 10 and 11, 1898. Blocks marked with an Arabic number and the letter (a), stood in a cool cellar from the time of taking from molds until shipped. Blocks marked with an Arabic number and the letter (b) were placed in open air when taken from molds, and exposed to the weather until shipped. Blocks marked with an

Arabic number and the letter (c) were placed in open air when taken from molds, but were covered with burlap and wet with water several times a day, until November 1, 1896, after which time they took the weather as it came until shipped. In addition to making the blocks in a series of four, each individual block receiving treatment as indicated in the foregoing, a series of blocks was further made with the mortar dry, plastic, and with water in excess, this latter condition being indicated by the word "excess" merely. In the dry blocks the mortar was, generally speaking, only a little more moist than damp earth. Such blocks required a large amount of ramming in order to flush the water to the surface. In the plastic blocks, the mortar was made of the ordinary consistency used by the average mason. A moderate amount of ramming brought the water to the surface in these blocks. In the excess blocks, the water was so far in excess that the concrete quaked like liver, under moderate ramming. In every case the mortars were mixed separately, a definite, measured quantity of cement, sand and stone being taken. The sand and cement were first thoroughly mixed dry, after which the proper quantity of water was added to produce mortar of the required consistency, followed by additional mixing. On referring to Table No. 1, it will be seen that the quantity of mortar used in each case was a certain per cent. of the broken stone. This means that a given quantity of broken stone was measured out, and a measured quantity of mortar of a given composition added. By way of illustration, we may refer to blocks 4, 4a, 4b, 4c, in which the mortar is 40 per cent. of the aggregate. For these blocks, 2 cubic feet of sand and 1 cubic foot of cement were measured out. After thorough dry-mixing, enough water was added to make a damp mortar. The amount of mortar after wet-mixing

was found, by actual measurement, to be 2.36 cubic feet. The sand weighed 92 pounds per cubic foot. The total weight of water used was 40 pounds, or 17 pounds of water per cubic foot of mortar. The quantity of stone measured out for this batch of concrete was 5 cubic feet, to which 2 cubic feet of the mortar, prepared as described in the foregoing, was added, and thoroughly mixed by repeated turning. The foregoing is the formula followed throughout the entire series of tests. The weight of the sand was taken from day to day. For this purpose a box holding exactly 1 cubic foot was provided, into which the sand was shoveled, and gently shaken, care being taken to make the manipulation the same for every measurement. Although the sand was stored in a dry cellar, considerable variations in weight per cubic foot were found, the range being from 86.5 pounds to 93.5 pounds. On this account the quantity of water used varied considerably, so much so, that no general rule as to use of water can be formulated. So far as can now be determined it must necessarily be a matter of judgment, purely. By way of determining the scientific fact, it might be well to carry out, at some future time, a third series of tests, in which the sand used should be made perfectly dry, artificially; in this way attaining the same scientific accuracy as in laboratory tests of cement. Taking into account the variations in weight of the sand, the following figures as to weight of water actually used per cubic foot of mortar must be considered as approximate only. As already stated, no hard-and-fast rule can be laid down. Good judgment must be exercised by the person in charge at every step in the process.

For the Genesee brand, in 1 to 1 mortars, the quantity of water was 20.9 pounds per cubic foot of dry mortar, 22.2 pounds per cubic foot of plastic mortar, and 24.3 pounds per cubic foot of ex-

cess mortar. For 2 to 1 mortars, the figures were: dry, 18.1 pounds; plastic, 22.4 pounds; excess, 23 pounds. Three to 1 mortars, dry, 18.5 pounds; plastic, 20.4 pounds; excess, 22.1 pounds. In 4 to 1, 5 to 1 and 6 to 1 mortars; dry, 17.5 pounds; plastic, 21 pounds; excess, 22 pounds.

For Millem's Wayland, the approximate figures are: 1 to 1, dry, 20 pounds; plastic, 21 pounds; excess, 23.6 pounds. For 2 to 1, 3 to 1, 4 to 1 and 5 to 1, dry, from 19.1 pounds to 19.7 pounds; plastic, 20.8 to 21.3 pounds; excess, 22.3 pounds to 23 pounds.

For the Empire brand, 2 to 1 mortars, dry, 20.3 pounds; plastic, 21.8 pounds; excess, 23 pounds. For 3 to 1 and 4 to 1 mortars, dry, from 18.3 to 19.1 pounds; plastic, 20.4 to 20.7 pounds; excess, 22.5 to 22.7 pounds.

For the Iron-Clad, 2 to 1 mortars, dry, 20.2 pounds; plastic, 21.2 pounds; excess, 22.9 pounds. Three to 1 and 4 to 1 mortars, dry, 21.1 to 21.3 pounds; plastic, 21.5 to 21.6 pounds; excess, 22.1 to 22.3 pounds.

Champion brand, 1 to 1 mortars, dry, 18.7; plastic, 21.9; excess, 22.4. Two to 1 and 3 to 1 mortars, dry, 18.5 to 18.8 pounds; plastic, 20 pounds; excess, 22.3 to 23.2 pounds.

The following are the means of all in pounds of water per cubic foot of mortar.

1 to 1.	2 to 1.	3 to 1.	4 to 1.	5 to 1.	Final mean.
		DRY.			
20.4	21.8	19.4	19.1	18.1	19.8
		PLASTIC.			
21.6	21.4	21.0	21.3	21.8	21.4
		EXCESS.			
23.9	22.7	21.6	22.2	22.0	22.5

Without being specially precise, these figures may be considered as giving a rough guide, either in actual practice on work, or for further experimentation.

The sand used was taken from the banks at Mount Morris, and was of the same general quality as indicated in the 1894 report.

In regard to expressing the quantity of mortar used in concrete as a percentage of the aggregate material, it may be remarked that such practice is, in my opinion, far superior to the old-fashioned formulæ, 1, 2, 5; 1, 3, 7, etc. Most of the contractors and engineers I have met, seem to have very far from clear ideas as to the theory of concrete, the fog being, without doubt, due, to some extent, to an erroneous nomenclature. The relation between the old formulæ and the expression of the mortar as a per cent. of the aggregate, is very simple. Thus, the common formula, 1 of cement, 3 of sand and 7 of broken stone, is really a 1 to 3 mortar, with the measured quantity of mortar about 33 per cent. of the measured quantity of broken stone. As proving this, we may consider that a barrel of cement and 3 barrels of sand, loosely measured, will make a little less than 2½ barrels of mortar, which is a little more than 33 per cent. of 7, the number of barrels of stone.

The following gives the record of the tensile tests of the several cements used in these tests, as made at the State Cement Testing office at Albany, the results being in pounds per square inch. All briquettes were kept in air 24 hours; the balance of the time in water. The figures represent, in each case, the average of 5 briquettes. For those marked A, standard quartz was used in mixing the mortar briquettes. For those marked B, the Mount Morris sand was used in mixing the mortar briquettes:

GENESEE BRAND.

(*A*) *Standard Quartz.*

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.	4 to 1.
6	417	223	169	115	70
13	496	....	....	....	....
20	534	....	....	....	....
27	527	320	220	136	91
Months.					
2	568	....	....	....	....
3	657	....	....	....	....
4	677	....	....	....	....
5	708	....	....	....	....
6½	851	....	....	....	....
(*B*) *Mount Morris Sand.*					
6	....	160	115	91	78
27	....	274	147	114	94

WAYLAND BRAND.

(*A*) *Standard Quartz.*

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.	4 to 1.
6	464	173	134	84	57
13	465	....	....	....	....
21	523	....	....	....	....
27	520	277	162	133	92
Months.					
2	534	....	....	....	....
3	596	....	....	....	....
4	652	....	....	....	....
5	691	....	....	....	....
6	782	....	....	....	....
(*B*) *Mount Morris Sand.*					
6	....	259	148	103	74
27	....	368	184	127	95

EMPIRE BRAND.

(A) Standard Quartz.

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.	4 to 1.
6	416	211	158	132	106
27	581	357	255	164	138
Months.					
2	604	....	....	....	....
3	620	....	....	....	....
4	683	....	....	....	....
5	686	....	....	....	....
6	729	....	....	....	....
(B) Mount Morris Sand.					
6	....	147	124	111	102
27	....	222	185	155	125

IRON-CLAD PORTLAND.

(A) Standard Quartz.

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.	4 to 1.
6	392	232	175	139	102
13	494	....	....	....	....
20	462	....	....	....	....
27	513	345	214	178	143
Months.					
2	534	....	....	....	....
3	577	....	....	....	....
4	590	....	....	....	....
5	598	....	....	....	....
6	639	....	....	....	....
(B) Mount Morris Sand.					
6	....	187	168	125	71
27	....	337	222	140	102

CHAMPION BRAND.

(*A*) *Standard Quartz.*

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.	4 to 1.
6	217	164	130	89	57
13	236	....	....	....	....
20	277	....	....	....	....
27	304	279	227	155	115
Months.					
2	320	....	....	....	....
3	365	....	....	....	....
4	390	....	....	....	....
5	407	....	....	....	....
6	484	....	....	....	....

(*B*) *Mount Morris Sand.*

6	....	147	122	69	41
27	....	249	211	110	59

BUFFALO PORTLAND BRAND.

(*A*) *Standard Quartz.*

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.	4 to 1.
6	217	155	109	63	44
13	224	....	....	....	....
20	243	....	....	....	....
27	256	237	132	106	95
Months.					
2	280	....	....	....	....
3	353	....	....	....	....
4	366	....	....	....	....
5	376	....	....	....	....
6	504	....	....	....	....

(*B*) *Mount Morris Sand.*

6	....	126	84	47	28
27	....	197	142	122	88

BUFFALO NATURAL.

(*A*) *Standard Quartz.*

Days.	Neat.	1 to 1.	2 to 1.	3 to 1.
6	169	141	91	57
13	213	....	....	....
20	226	....	....	....
27	241	232	159	101
Months.				
2	330	....	....	....
3	331	....	....	....
4	343	....	....	....
5	331	....	....	....
6	358	....	....	....

The foregoing tests show that there is no great difference between the Genesee, Millem's Wayland and Empire brands. Assuming equal care in manufacturing, this is as might be expected. These cements are all marl cements, and presumably do not vary greatly in composition. The following is an analysis of the Wayland marl, as furnished by Mr. Millem a few years ago:

	Per cent.
Insoluble matter, sand or silica	1.90000
Iron and alum	0.9200
Sulphate of lime	0.3267
Lime	51.4425
Magnesia	1.5280
Carbonic acid	38.6800
Organic matter, moisture and loss	5.2028
	100.0000

The clay used in the Wayland brand has the following analysis:

	With moisture.	Without moisture.
	Per cent.	Per cent.
Moisture	6.5492	0
Silica	51.0000	54.5741
Sulphate of lime	0.7254	0.7762
Iron sesquioxide	2.3750	2.5414
Alumina	29.6250	31.7010
Lime calcium oxide	4.6818	5.0099
Magnesia, magnesium oxide	4.0648	4.3496
Alkali (by difference)	0.9788	1.0479
	100.0000	100.0000

The Iron-Clad brand is produced by a different process. In manufacturing this cement, a limestone rock is first finely ground and then mixed with the proper proportion of clay before burning into clinker, the ground limestone, in this case, taking the place of the natural marls used in the Genesee, Wayland and Empire brands. The following is the average analysis of the Iron-Clad brand as given in the Glens Falls Portland Cement Company's pamphlet:

	Per cent.
Lime	63.50
Silicic acid	21.50
Clay and iron oxide	10.50
Magnesia	1.80
Alkalies	0.40
Sulphuric acid	1.50
Loss	0.80
	100.00

The Champion brand is a sand-silica cement, the cement base being the Iron-Clad brand just referred to. The tests show that this is apparently a satisfactory cement, although not attaining in six months nearly as much strength as the pure Portlands. According to the company's circular, the average of tests made at the Silica Portland Cement Company's factory at Long Island City, New York, during the year 1895, as reported by Daniel E. Moran, President of the company, was as follows, the cement being Iron-Clad Portland, mixed with two parts of finely ground sand: For seven days' test, average tensile strength, 349 pounds per square inch; fourteen days' test, 396 pounds per square inch; twenty-eight days' test, 429 pounds per square inch; eighty-four days' test, 544 pounds per square inch.

The following are the averages of a number of tests of the Iron-Clad brand as made within the last few months at the Indian river dam: Neat cement, one day in air and six days in water, average tensile strength, 684 pounds per square inch; 3 to 1 mortar, made with sand from lake beach, average tensile strength in seven days, 195 pounds per square inch. The relative values of these several cements for concrete making are so clearly shown in Table No. 1, as to make discussion of that question unnecessary here.

Under an arrangement with the commanding officer at the United States Arsenal, Watertown, Massachusetts, the blocks were broken there, without any expense to the State of New York other than their delivery at the arsenal. The results may be relied upon, as the best attainable in the United States, the breakings having been made on the large 800,000-pound testing machine at the arsenal. We are especially indebted to Major J. W. Reilly, of the Ordnance Department, Commandant, and to J.

E. Howard, C. E., in charge of the testing machine, for many courtesies received. The results are all certified to by Mr. Howard, as well as signed by Major Reilly, the Commandant.

By way of illustrating the extent of the concrete tests carried out by the State Engineer and Surveyor's Department, it may be mentioned that the tests of 1893 included 173 blocks. The following are the blocks of the present tests:

Genesee brand	112
Wayland	120
Iron-Clad	84
Empire	96
Champion	84
Buffalo Portland	12
Buffalo Natural	36
Total	544

In both sets of tests, the blocks were all cubes of a foot, this size insuring what may be properly termed purely practical tests, in contradistinction to the great bulk of laboratory tests which have mostly been made on concrete cubes of from 3 to 5 inches.

We may now proceed to a description of the tables. In Table No. 1, we have presented the general data of the tests. As will be seen by examining this table, the blocks of each series stand by themselves; all blocks with the same Arabic numeral were made at the same time, and have precisely the same composition, but blocks 1, 1a, 1b and 1c, etc., have each received different treatment as regards exposure to weather conditions. For instance, block 1 was placed in water when taken from the molds, as already described; block 1a stood in a cool cellar; block 1b was placed

in the open air and exposed to the weather, and block 1c was placed in the open air, but covered with burlap, and wet with water several times a day, as described on a previous page. The same arrangement holds throughout the whole of Table No. 1. Column (2) gives the date of fabrication of the blocks in the year 1896; Column (3), the date of test at Watertown arsenal in 1898; Column (4), the age of each block in days; Columns (5) and (6), the temperature of air and water on date of making; Column (7), the consistency of the mortar as to whether dry, plastic, or with water in excess; Column (8), the brand of cement used; Column (9), the parts by volume of cement in the mortar; Column (10), the weight per cubic foot of the cement in pounds, as determined by Mr. Faija's method; Column (11), parts by volume of sand used in the mortar; Column (12), the ratio of the amount of stone used to the mortar, in per cent.; Column (13), the hours each block remained in the molds; Column (14), the total weight of each block in pounds; Column (15), the weight of each block per cubic foot; Columns (16), (17) and (18), the dimensions of the blocks; Column (19), the sectional area in square inches; Column (20), the first crack in pounds on the block; Column (21), the ultimate total strength of each block in pounds; Column (22), the ultimate strength per square inch; Column (23), the mean ultimate strength per square inch of each series; and Column (24), remarks and explanations.

In Table No. 2, we have a comparison of those blocks in which the mortar was made 33 per cent. of the aggregate material with reference to amount of water used in mortar, the comparison being based upon means of the ultimate strength per square inch, as per Column (23) of Table No. 1. Column (1) of this table gives the quality of the mortar; Columns (2), (4), (6), (8) and (10),

the serial numbers or marks of the blocks, as per Table No. 1, and Columns (3), (5), (7), (9) and (11), the means of the ultimate strength per square inch, as per Column (23) of Table No. 1. In the second part of Table No. 2, the 1 to 2 and 1 to 3 blocks, dry, plastic and excess, are compared, the means being carried out in Column (12).

Table No. 3 is a similar comparison for blocks with mortar 40 per cent. of the aggregate. Comparing Columns (12) of Tables Nos. 2 and 3, it is seen that while in both 33 and 40 per cent. mortar blocks, the dry blocks are considerably stronger than those with water in the mortar used in excess, still, the difference between the 33 per cent. mortar blocks and 40 per cent. mortar blocks is not very great.

In Table No. 4, we have a summary of Tables Nos. 2 and 3. The difference in strength between dry, plastic and excess blocks is strongly brought out by this table.

In Table No. 5, we have a comparison of concrete blocks in which the mortar was 33 per cent. of the aggregate material, with reference to condition and consistency of mortar. The first part (0) of the table includes the 33 per cent. blocks that were kept under theoretical conditions, that is, were placed in water after taking from the molds where they remained until December 1, 1896, on which date they were buried in sand and remained until taken out for shipment January 10 and 11, 1898. The second part (A) includes the blocks that were stored in a cool cellar from the date of making until they were shipped for test on January 10 and 11, 1898. The third part (B) includes the blocks fully exposed to weather, and the fourth part (C) those covered with burlap and wet several times a day, up to November 1, 1896. A similar division will be found in Tables Nos. 6, 7, 8, 9 and 10.

Column (1) of Table No. 5 gives the quality of the mortar; Columns (2), (4), (6), (8), (10), (12), (14), (16), (18), (20), (22), (24), (26), (28) and (30) give the serial number of each block as per Table No. 1; and Columns (3), (5), (7), (9), (11), (13), (15), (17), (19), (21), (23), (25), (27), (29) and (31) give the ultimate strength in pounds per square inch on each block, as per Column (22) of Table No. 1. The data for each cement are as indicated by the headings. In examining Table No. 5, it will be seen that the number of blocks are not the same for different qualities of mortar as per Column (1), and at first thought it might appear that, due to this circumstance, comparison by means is impracticable. The means, however, are not to be compared across the table, but vertically, thus: In Column (3) for the Genesee brand with dry mortar, we have the means of (0), 2829; the means of (A), 2659; the means of (B), 2179, and the means of (C), 2464. It is obvious that a comparison of the means can be made in this way, and safe results attained.

Table No. 6 is a similar comparison to Table No. 5, of the blocks in which the mortar was 40 per cent. of the aggregate material.

Table No. 7 is a summary of Tables Nos. 5 and 6. Column (1) of this table indicates the per cent. of mortar in the blocks for the different conditions (0), (A), (B) and (C) and Columns (2), (3), (4), (6), (7), (8), (10), (11), (12), (14), (15), (16), (18), (19) and (20), the consistency of the mortar; Columns (5), (9), (13), (17), (21) and (22), are the means. In this case it is considered fair to use means across the table, not as indicating absolute values, but as illustrating the persistency of the general law that blocks (0) are the strongest of all; blocks (A) the next strongest; blocks (B) the weakest of all, and blocks (C) somewhat stronger than (B).

Table No. 8 gives the comparison of the 1 to 2, 1 to 3 and 1 to 4 blocks, in which the mortar was 33 per cent. of the aggregate, with reference to quality of mortar and consistency of the same under the several conditions. Column (1) of this table designates the brand of cement; Columns (2), (4), (6), (8), (10), (12), (14), (16) and (18) the serial number as per Table No. 1, and Columns (3), (5), (7), (9), (11), (13), (15), (17) and (19), the ultimate strength in pounds per square inch, as per Column (22), of Table No. 1. The means of this table should be read vertically, the same as described for a previous table.

Table No. 9 is a similar showing to that of Table No. 8, but with the mortar 40 per cent. of the aggregate material.

Table No. 10 is a summary of Tables Nos. 8 and 9. The means are carried out across this table, the same as in Table No. 7, for the purpose of exhibiting the law of strength under the several conditions.

Tables 11 to 17, inclusive, contain information of great interest with reference to the compressibility, elasticity and modulus of elasticity as determined for the different blocks. On this part of the work much more was done by the Federal authorities at the Watertown Arsenal than was expected, and our thanks are accordingly due to the Commandant of the arsenal for the extensive manner in which this part of the subject was treated.

The results of the tests are so thoroughly exhibited by Tables Nos. 2 to 10, inclusive, as to make extended reference to them unnecessary. One final remark may be made, however, that these tests were, in every sense, practical. That is to say, the various details carried out in the tests can be produced in actual work without adding unduly to the cost. As to concretes made with dry mortars, it may be further remarked, that while the use of

such requires more labor of ramming, still, careful observations made at Indian River dam now under construction, indicate that the cost of the additional ramming is very small. As regards concretes made with mortar, 33 per cent. of the aggregate, versus that with the mortar 40 per cent. of the aggregate, it may be also pointed out that the gain of strength by use of additional mortar is seen to be only slight. The real point appears to be, to so thoroughly mix the concrete as to insure the thorough smearing of every piece of broken stone with mortar. By so doing, and by the use of thorough ramming, practically as strong concretes are produced with the smaller quantity of mortar as with the larger. It is needless to remark that ordinarily the cost of the additional ramming will be less for the concretes made with 33 per cent, mortar, than the cost of the additional cement in the 40 per cent. mortar. The tests seem to indicate, therefore, the utility of using only enough mortar to just about fill the voids after ramming, and to depend upon thorough ramming for the strength and solidity of the concrete.

Very respectfully,

GEORGE W. RAFTER.

MORTAR — 33 PER CENT. OF THE AGGREGATE.

TABLE No. 2.

Comparison of Concrete Blocks with Reference to Amount of Water Used in Mortar.

[Comparison based upon Means of the ultimate strength per square inch as per Column 23, of Table No. 1.]

QUALITY OF MORTAR.	GENESEE.		WAYLAND.		IRON-CLAD.		EMPIRE.		CHAMPION.		
	Serial number.	Col. 23 of Table 1.	Serial number.	Col. 23 of Table 1.	Serial number.	Col. 23 of Table 1.	Serial number.	Col. 23 of Table 1.	Serial number.	Col 23 of Table 1.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
DRY.											
1 to 1	7	4,130	29	4,267	....	......	....	......	95	2,659	
1 to 2	1	2,852	30	2,488	59	2,777	77	3,265	96	2,289	
1 to 3	8	3,065	31	2,056	60	1,501	78	1,992	97	1,401	
1 to 4	9	2,059	32	1,810	61	1,412	79	1,666	....	......	
1 to 5	10	1,664	33	1,537	....	......	....	......	....	......	
1 to 6	11	1,427	....	......	....	.....	....	......	....	......	
PLASTIC.											
1 to 1	12	3,505	34	4,072	....	......	....	......	98	2,598	
1 to 2	22*	2,962	35	2,777	62	2,552	80	2,529	99	2,146	
1 to 3	13	2,311	36	2,207	63	1,750	81	2,014	100	1,337	
1 to 4	14	2,036	37	1,600	64	1,434	82	1,523	....	......	
1 to 5	15	1,801	38	1,568	....	......	....	......	....	......	
1 to 6	....	....	....	......	....	......	....	......	....	......	
EXCESS.											
1 to 1	16	3,622	39	3,764	....	......	....	......	101	2,279	
1 to 2	17	2,524	40	2,847	65	2,436	83	2,899	102	1,862	
1 to 3	18	2,255	41	1,723	66	1,718	84	1,898	103	1,168	
1 to 4	3	2,416	42	1,767	67	1,594	85	1,488	....	......	
1 to 5	....	....	43	1,441	....	......	....	......	....	......	
1 to 6	....	....	....	......	....	......	....	......	....	......	

TABLE No. 11.

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 7.

Sectional area, 144.24 square inches. Gauged length, 5 square inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,272	300	.0003	0	
57,696	400	.0005	0	
86,544	600	.0009	.0002	
115,392	800	.0015	.0003	
144,240	1,000	.0021	.0005	
173.088	1,200	.0028	.0007	
201,936	1,400	.0036	.0009	
230,784	1,600	.0044	.0012	
259,632	1,800	.0054	.0016	
288,480	2,000	.0066	.0020	
317,328	2,200	.0080	.0024	
346,176	2,400	.0095	.0033	
375,024	2,600	.0111	.0039	
403,872	2,800	.0135	.0056	
432,720	3,000	.0149	.0062	
461,568	3,200	.0175	.0076	First crack.
490,416	3,400	.0197	.0088	
519,264	3,600	.0230	.0107	
548,112	3,800	.0256	.0123	
576,960	4,000	.0289	.0141	
672,000	4,659	....	....	Ultimate strength.

MARKS, 7a.

Sectional area, 143.88 square inches. Gauged length, 5 inches.

14,388	100	0	0	Initial load
28,776	200	.0005	.0001	
43,164	300	.0009	.0002	
57,552	400	.0012	.0004	
71,940	500	.0017	.0006	
86,328	600	.0022	.0008	
100,716	700	.0028	.0010	
115,104	800	.0035	.0012	
129,492	900	.0043	.0015	
143,880	1,000	.0050	.0019	
158,268	1,100	.0059	.0022	
172,656	1,200	.0069	.0027	
187,044	1,300	.0079	.0033	
201,432	1,400	.0089	.0038	
215,820	1,500	.0102	.0045	
230,208	1,600	.0114	.0052	
244,596	1,700	.0127	.0060	
250,000	....	....	....	First crack.
258,984	1.800	.0141	.0071	
273,372	1,900	.0153	.0080	
287,760	2,000	.0168	.0089	
302,148	2,100	.0179	.0097	
316 536	2,200	.0193	.0107	
330,924	2,300	.0206	.0116	
345,312	2,400	.0216	.0125	
359,700	2,500	.0230	.0134	
374,088	2,600	.0241	.0142	
388,476	2,700	.0252	.0151	
402,864	2,800	.0268	.0161	
417,252	2,900	.0281	.0171	
431,640	3,000	.0294	.0180	
583,400	4,055	....	....	Ultimate strength.

TABLE No. 11.—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 12.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0001	0	
43,236	300	.0003	0	
57,648	400	.0006	0	
86,472	600	.0012	.0001	
115,296	800	.0019	.0004	
144,120	1,000	.0027	.0006	
172,944	1,200	.0036	.0009	
201,768	1,400	.0046	.0013	
230,592	1,600	.0057	.0016	
259,416	1,800	.0073	.0024	
288,240	2,000	.0089	.0033	
317,064	2,200	.0107	.0042	
345,888	2,400	.0129	.0058	
374,712	2,600	.0147	.0069	
403,536	2,800	.0164	.0079	
430,000	....	....	....	First crack.
432,360	3,000	.0170	.0085	
461,184	3,200	.0178	.0090	
490,008	3,400	.0194	.0097	
518,832	3,600	.0218	.0108	
547,656	3,800	.0252	.0083	Ultimate strength.

MARKS, 16.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,436	100	0	0	Initial load.
28,872	200	.0002	0	
43,308	300	.0005	.0000	
57,744	400	.0008	.0001	
86,616	600	.0015	.0003	
115,488	800	.0022	.0007	
144,360	1,000	.0043	.0011	
173,232	1,200	.0046	.0017	
202,104	1,400	.0061	.0023	
230,976	1,600	.0081	.0032	
259,848	1,800	.0098	.0043	
288,720	2,000	.0120	.0055	
317,592	2,200	.0142	.0068	First crack.
346,464	2,400	.0169	.0082	
375,336	2,600	.0192	.0097	
404,208	2,800	.0219	.0113	
433,080	3,000	.0246	.0130	
461,952	3,200	.0277	.0151	
490,824	3,400	.0318	.0177	
519,696	3,600	.0479	.0225	
548,100	3,797	.0452	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 1.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,460	100	0	0	Initial load.
28,920	200	.0001	0	
43,380	300	.0002	0	
57,840	400	.0004	0	
86,760	600	.0008	.0001	
115,680	800	.0012	.0002	
144,600	1,000	.0015	.0004	
173,520	1,200	.0020	.0005	
202,440	1,400	.0025	.0007	
231,360	1,600	.0031	.0009	
260,280	1,800	.0037	0011	
289,200	2,000	.0045	.0014	
318,120	2,200	.0053	.0016	
347,040	2,400	.0061	.0020	
375,960	2,600	.0071	.0024	First crack.
404,880	2,800	.0082	.0030	
433,800	3,000	.0092	.0034	
462,720	3,200	.0105	.0042	
491,640	3,400	.0120	.0053	
520,560	3,600	.0131	.0063	
532,100	3,680	....	....	Ultimate strength.

MARKS, 17.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0015	.0012	
43,380	300	.0036	.0031	
57,840	400	.0057	.0047	
86,760	600	.0088	.0073	
115,680	800	.0119	.0095	
144,600	1,000	.0150	.0118	
173,520	1,200	.0181	.0143	
202,440	1,400	.0220	.0172	
231,360	1,600	.0254	.0199	
260,280	1,800	.0295	.0232	First crack.
289,200	2,000	.0343	.0270	
318,120	2,200	.0390	.0311	
347,040	2,400	.0495	.0395	
375,960	2,600	.0579	.0455	
419,600	2,902	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 8.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch	Set. Inch.	
14,412	100	0	0	Initial load.
28,824	200	.0001	0	
43,236	300	.0002	0	
57,648	400	.0004	.0001	
86,472	600	.0009	.0001	
115,296	800	.0015	.0003	
144,120	1,000	.0022	.0005	
172,944	1,200	.0031	.0007	
201,768	1,400	.0039	.0010	
230,592	1,600	.0052	.0014	
259,416	1,800	.0067	.0019	
288,240	2,000	.0090	.0031	
28,824	200	.0033	....	
57,648	400	.0040	....	
86,472	600	.0048	....	
115,296	800	.0057	....	
144,120	1,000	.0063	....	
172,944	1,200	.0070	....	
201,768	1,400	.0076	....	
230,592	1,600	.0081	....	
259,416	1,800	.0087	....	
230,592	1,600	.0084	....	
201,768	1,400	.0081	....	
172,944	1,200	.0077	....	
144,120	1,000	.0075	....	
115,296	800	.0069	....	
86,472	600	.0063	....	
57,648	400	.0055	....	
28,824	200	.0042	.0036	
310,000	....	....	....	First crack.
317,064	2,200	.0112	....	
345,888	2,400	.0130	....	
374,712	2,600	.0154	....	
403,536	2,800	.0184	....	
432,360	3,000	.0216	....	
474,000	3,289	....	....	Ultimate strength.
MARKS, 2.				
Sectional area, 144.12 square inches. Gauged length, 5 inches.				
14,412	100	0	0	Initial load.
28,824	200	.0007	.0004	
43,236	300	.0020	.0013	
57,648	400	.0035	.0025	
86,472	600	.0063	.0046	
115,296	800	.0095	.0069	
144,120	1,000	.0124	.0094	
172,944	1,200	.0161	.0120	
201,768	1,400	.0197	.0147	First crack.
230,592	1,600	.0232	.0175	
259,416	1,800	.0273	.0206	
288,240	2,000	.0307	.0229	
317,064	2,200	.0352	.0260	
345,888	2,400	.0395	.0308	
374,712	2,600	.0468	.0341	
403,536	2,800	.0546	.0398	
435,500	3,022	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 13.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0004	.0001	
43,236	300	.0008	.0004	
57,648	400	.0013	.0006	
86,472	600	.0025	.0014	
115,296	800	.0040	.0022	
144,120	1,000	.0057	.0036	
172,944	1,200	.0078	.0050	
201,768	1,400	.0100	.0066	
230,592	1,600	.0125	.0083	
250,000	....	....	....	First crack.
259,416	1,800	.0148	.0098	
288,240	2,000	.0178	.0114	
317,064	2,200	.0199	.0132	
345,888	2,400	.0220	.0145	
374,712	2,600	.0261	.0098	
386,300	2,680	....	....	Ultimate strength.

MARKS, 12.

Sectional area, 145.56 square inches. Gauged length, 5 inches.

14,556	100	0	0	Initial load.
29,112	200	.0028	.0025	
43,668	300	.0045	.0039	
58,224	400	.0058	.0050	
87,336	600	.0084	.0068	
116,448	800	.0105	.0084	
145,560	1,000	.0126	.0098	
174,672	1,200	.0148	.0112	
203,784	1,400	.0174	.0130	
232,896	1,600	.0202	.0148	First crack.
262,008	1,800	.0175	.0113	Cracks developed in vicinity of the micrometer.
291,120	2,000	.0197	.0117	Cracks developed in vicinity of the micrometer.
320,232	2,200	.0217	.0095	Cracks developed in vicinity of the micrometer.
397,100	2,728	....	....	Ultimate strength.

MARKS, 9.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

14,412	100	0	0	Initial load.
28,824	200	.0003	.0001	
43,236	300	.0009	.0003	
57,648	400	.0014	.0007	
86,472	600	.0031	.0015	
115,296	800	.0050	.0026	
144,120	1,000	.0078	.0044	
172,944	1,200	.0106	.0064	
201,768	1,400	.0133	.0083	
230,000	....	....	....	First crack.
230,592	1,600	.0165	.0105	
259,416	1,800	.0196	.0123	
288,240	2,000	.0239	.0149	
317,064	2,200	.0278	.0164	
319,900	2,220	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 14.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,472	100	0	0	Initial load,
28,944	200	.0042	.0038	
43,416	300	.0079	.0070	
57,888	400	.0112	.0097	
86,832	600	.0160	.0137	
115,776	800	.0201	.0172	
144,720	1,000	.0230	.0191	
173,664	1,200	.0261	.0215	First crack.
202,608	1,400	.0290	.0236	
306,800	2,120	....	....	Ultimate strength.

MARKS, 8.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0007	.0001	
57,840	400	.0012	.0003	
72,300	500	.0018	.0006	
86,760	600	.0025	.0009	
101,220	700	.0032	.0013	
115,680	800	.0039	.0017	
130,140	900	.0046	.0022	
144,600	1,000	.0055	.0028	
159,060	1,100	.0065	.0036	
173,520	1,200	.0076	.0042	
187,980	1,300	.0086	.0049	
202,440	1,400	.0098	.0057	
216,900	1,500	.0106	.0063	
231,360	1,600	.0119	.0073	
245,820	1,700	.0131	.0080	First crack.
260,280	1,800	.0141	.0086	
274,740	1,900	.0158	.0099	
289,200	2,000	.0173	.0109	
303,660	2,100	.0187	.0118	
318,120	2,200	.0184	.0116	Surface of cube generally cracked. Local effects influence the micrometer.
332,580	2,300	.0165	.0094	
370,800	2,564	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 10.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,424	100	0	0	Initial load.
28,848	200	.0007	.0004	
43,272	300	.0015	.0010	
57,696	400	.0030	.0021	
72,120	500	.0041	.0029	
86,544	600	.0061	.0043	
100,968	700	.0081	.0059	
115,392	800	.0101	.0074	
129,816	900	.0120	.0091	
144,240	1,000	.0145	.0108	
158,664	1,100	.0172	.0130	
163,000	....	....	....	First crack.
173,088	1,200	.0205	.0155	
187,512	1,300	.0237	.0178	
201,936	1,400	.0269	.0205	
216,360	1,500	.0314	.0238	
230,784	1,600	.0364	.0279	
253,800	1,760	....	....	Ultimate strength.

MARKS, 10a.

Sectional area, 143.64 square inches. Gauged length, 5 inches.

14,364	100	0	0	Initial load.
28,728	200	.0008	.0004	
43,092	300	.0014	.0010	
57,456	400	.0026	.0016	
71,820	500	.0038	.0024	
86,184	600	.0054	.0034	
100,548	700	.0068	.0043	
114,912	800	.0085	.0056	
129,276	900	.0103	.0071	
143,640	1,000	.0117	.0079	
158,004	1,100	.0135	.0091	
172,368	1,200	.0156	.0105	
186,730	1,300	.0173	.0116	
200,000	....	....	....	First crack.
201,094	1,400	.0191	.0129	
215,458	1,500	.0203	.0135	
229,822	1,600	.0211	.0136	
254,900	1,775	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 15.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch	Remarks.
14,448	100	0	0	Initial load.
28,896	200	.0012	.0009	
43,344	300	.0026	.0019	
57,792	400	.0037	.0027	
72,240	500	.0048	.0035	
86,688	600	.0059	.0042	
101,136	700	.0071	.0051	
115,584	800	.0082	.0059	
130,032	900	.0096	.0069	
144,480	1,000	.0108	.0078	
158,928	1,100	.0122	.0088	
173,376	1,200	.0136	.0097	
187,824	1,300	.0151	.0108	First crack.
202,272	1,400	.0171	.0121	
216,720	1,500	.0187	.0134	
231,168	1,600	.0209	.0147	
245,616	1,700	.0232	.0165	
260,064	1,800	.0258	.0182	
274,512	1,900	.0287	.0210	
287,700	1,991	....	....	Ultimate strength.

MARKS, 11.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

14,436	100	0	0	Initial load.
28,872	200	.0011	.0007	
43,308	300	.0031	.0021	
57,744	400	.0052	.0038	
86,616	600	.0104	.0081	
115,488	800	.0170	.0135	
142,000	....	....	....	First crack.
144,360	1,000	.0249	.0204	
173,232	1,200	.0349	.0281	
197,100	1,365	....	....	Ultimate strength.

MARKS, 25.

Sectional area, 146.40 square inches. Gauged length, 5 inches.

14,640	100	0	0	Initial load.
29,280	200	.0001	0	
43,920	300	.0004	0	
58,560	400	.0007	0	
87,840	600	.0015	.0001	
117,120	800	.0023	.0005	
146,400	1,000	.0033	.0008	
175,680	1,200	.0046	.0013	
204,960	1,400	.0062	.0021	
234,240	1,600	.0085	.0035	
263,520	1,800	.0103	.0044	
292,800	2,000	.0128	.0060	
322,080	2,200	.0152	.0073	
351,360	2,400	.0178	.0088	
380,640	2,600	.0201	.0102	
401,000	....	....	....	First crack.
409,920	2,800	.0227	.0120	
439,200	3,000	.0254	.0135	
468,480	3,200	.0284	.0152	
539,400	3,684	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 25a.

Sectional area, 143.76 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,376	100	0	0	Initial load.
28,752	200	.0005	.0001	
43,128	300	.0010	.0003	
57,504	400	.0015	.0006	
71,880	500	.0021	.0009	
86,256	600	.0029	.0012	
100,632	700	.0038	.0015	
115,008	800	.0047	.0020	
129,384	900	.0059	.0028	
143,760	1,000	.0071	.0034	
158,136	1,100	.0086	.0042	
172,512	1,200	.0100	.0051	
186,888	1,300	.0120	.0065	
200,000	....	....	....	First crack.
201,264	1,400	.0138	.0077	
215,640	1,500	.0155	.0089	
230,016	1,600	.0179	.0105	
244,392	1,700	.0199	.0118	
258,768	1,800	.0219	.0138	
273,144	1,900	.0242	.0150	
287,520	2,000	.0263	.0165	
301,896	2,100	.0285	.0188	
316,272	2,200	.0311	.0211	
427,800	2,976	....	....	Ultimate strength.

MARKS, 4.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0002	0	
43,236	300	.0006	0	
57,648	400	.0008	.0001	
86,472	600	.0014	.0002	
115,296	800	.0022	.0006	
144,120	1,000	.0030	.0008	
172,944	1,200	.0040	.0012	
201,768	1,400	.0051	.0017	
230,592	1,600	.0063	.0022	
259,416	1,800	.0077	.0028	
288,240	2,000	.0094	.0037	
317,064	2,200	.0110	.0046	
345,888	2,400	.0130	.0060	First crack.
374,712	2,600	.0153	.0077	
403,536	2,800	.0172	.0086	
432,360	3,000	.0189	.0099	
461,184	3,200	.0216	.0118	
490,008	3,400	.0260	.0144	
415,200	2,881	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 19.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0002	0	
43,236	300	.0006	.0001	
57,648	400	.0010	.0002	
86,472	600	.0018	.0005	
115,296	800	.0028	.0010	
144,120	1,000	.0039	.0014	
172,944	1,200	.0052	.0021	
201,768	1,400	.0066	.0028	
230,592	1,600	.0083	.0036	
259,416	1,800	.0101	.0045	
288,240	2,000	.0124	.0060	
317,064	2,200	.0144	.0074	
345,888	2,400	.0171	.0088	First crack.
374,712	2,600	.0202	.0110	
403,536	2,800	.0241	.0138	
432,360	3,000	.0295	.0178	
486,000	3,372	....	....	Ultimate strength.

MARKS, 22.

Sectional area, 145.08 square inches. Gauged length, 5 inches.

Applied Loads. Total pounds	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,508	100	0	0	Initial load.
29,016	200	0	0	
43,524	300	.0002	0	
58,032	400	.0004	0	
87,048	600	.0009	.0001	
116,064	800	.0014	.0003	
145,080	1,000	.0022	.0006	
174,096	1,200	.0030	.0009	
203,112	1,400	.0040	.0012	
232,128	1,600	.0049	.0017	
261,144	1,800	.0062	.0023	
290,160	2,000	.0076	.0030	
319,176	2,200	.0092	.0040	
348,192	2,400	.0110	.0050	
375,000	....	....	....	First crack.
377,208	2,600	.0130	.0062	
406,224	2,800	.0155	.0079	
435,240	3,000	.0185	.0096	
464,256	3,200	.0237	.0124	
493,272	3,400	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 26.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,436	100	0	0	Initial load.
28,872	200	.0003	.0001	
43,308	300	.0007	.0002	
57,744	400	.0011	.0003	
72,180	500	.0015	.0005	
86,616	600	.0022	.0009	
101,052	700	.0033	.0016	
115,488	800	.0040	.0020	
129,924	900	.0048	.0025	
144,360	1,000	.0059	.0032	
158,796	1,100	.0074	.0041	
173,232	1,200	.0088	.0050	
187,668	1,300	.0103	.0060	
202,104	1,400	.0117	.0072	
216,540	1,500	.0135	.0084	
230,976	1,600	.0153	.0097	
245,412	1,700	.0172	.0110	
259,848	1,800	.0188	.0120	First crack.
274,284	1,900	.0204	.0130	
288,720	2,000	.0224	.0145	
303,156	2,100	.0250	.0166	
317,592	2,200	.0276	.0183	
332,028	2,300	.0305	.0206	
394,000	2,729	......	......	Ultimate strength.

MARKS, 5.

Sectional area, 143.64 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,364	100	0	0	Initial load.
28,728	200	.0002	.0001	
43,092	300	.0005	.0002	
57,456	400	.0008	.0003	
86,184	600	.0017	.0007	
114,912	800	.0030	.0014	
143,640	1,000	.0045	.0022	
172,368	1,200	.0067	.0036	
201,096	1,400	.0092	.0052	
229,824	1,600	.0121	.0074	
258,552	1,800	.0152	.0097	First crack.
287,280	2,000	.0191	.0124	
316,008	2,200	.0228	.0152	
344,736	2,400	.0274	.0189	
373,464	2,600	.0343	.0246	
402,192	2,800	.0428	.0317	
411,400	2,864	....	....	Ultimate strength.

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 20.

Sectional area, 143.88 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,388	100	0	0	Initial load.
28,776	200	.0002	0	
43,164	300	.0007	.0002	
57,552	400	.0013	.0004	
86,328	600	.0028	.0013	
115,104	800	.0046	.0025	
143,880	1,000	.0070	.0040	
172,656	1,200	.0096	.0061	
201,432	1,400	.0122	.0081	
230,208	1,600	.0155	.0103	First crack.
258,984	1,800	.0187	.0129	
287,760	2,000	.0228	.0158	
316,536	2,200	.0270	.0185	
345,312	2,400	.0320	.0220	
374,088	2,600	....	....	Ultimate strength.

MARKS, 23.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

14,448	100	0	0	Initial load.
28,896	200	.0003	.0001	
43,344	300	.0009	.0004	
57,792	400	.0015	.0007	
72,240	500	.0022	.0012	
86,688	600	.0036	.0016	
101,136	700	.0040	.0022	
115,584	800	.0048	.0028	
130,032	900	.0060	.0035	
144,480	1,000	.0071	.0041	
158,928	1,100	.0081	.0049	
173,376	1,200	.0094	0059	
187,824	1,300	.0104	.0066	
202,272	1,400	.0118	.0077	First crack.
216,720	1,500	.0133	.0087	
231,168	1,600	.0147	.0091	
245,616	1,700	.0159	.0105	
348,000	2,409	....	....	Ultimate strength.

MARKS, 27.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

14,460	100	0	0	Initial load.
28,920	200	.0005	.0002	
43,380	300	.0010	.0005	
57,840	400	.0016	.0008	
86,760	600	.0033	.0017	
115,680	800	.0053	.0030	
144,600	1,000	.0079	.0046	
173,520	1,200	.0106	.0071	
202,440	1,400	.0140	.0088	
231,360	1,600	.0171	.0110	
260,280	1,800	.0214	.0142	First crack.
289,200	2,000	.0265	.0175	
318,120	2,200	.0338	.0221	
346,500	2,396	....	....	Ultimate strength

TABLE No. 11—(*Continued*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 21.

Sectional area, 143.40 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,340	100	0	0	Initial load.
28,680	200	.0004	.0001	
43,020	300	.0011	.0006	
57,360	400	.0019	.0011	
86,040	600	.0039	.0025	
114,720	800	.0069	.0044	
143,400	1,000	.0100	.0071	
172,080	1,200	.0140	.0100	
200,760	1,400	.0187	.0137	First crack.
229,440	1,600	.0239	.0177	
258,120	1,800	.0301	.0224	
282,000	1,967	.0379	....	Ultimate strength.

MARKS, 24.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

14,436	100	0	0	Initial load.
28,872	200	.0003	.0001	
43,308	300	.0007	.0002	
57,744	400	.0012	.0004	
86,616	600	.0023	.0011	
115,488	800	.0040	.0019	
144,360	1,000	.0060	.0033	
173,232	1,200	.0081	.0046	
202,104	1,400	.0102	.0063	
230,976	1,600	.0126	.0079	First crack.
259,848	1,800	.0151	.0098	
288,720	2,000	.0163	.0097	
299,800	2,077	....	....	Ultimate strength.

MARKS, 6.

Sectional area, 143.88 square inches. Gauged length, 5 inches.

14,388	100	0	0	Initial load.
28,776	200	.0004	.0001	
43,164	300	.0010	.0003	
57,552	400	.0016	.0007	
71,940	500	.0023	.0011	
86,328	600	.0030	.0015	
100,716	700	.0039	.0022	
115,104	800	.0052	.0030	
129,492	900	.0068	.0042	
143,880	1,000	.0079	.0048	
158,268	1,100	.0096	.0060	
172,656	1,200	.0113	.0075	
187,044	1,300	.0131	.0087	
201,432	1,400	.0150	.0103	
215,820	1,500	.0180	.0126	
230,208	1,600	.0201	.0143	First crack.
244,596	1,700	.0226	.0161	
258,984	1,800	.0255	.0182	
273,372	1,900	.0280	.0200	
287,760	2,000	.0303	.0218	
345,600	2,402	....	....	Ultimate strength.

TABLE No. 11—(*Concluded*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKED, 22.

Sectional area, 145.10 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
[illegible]	100	0	0	Initial load.
[illegible]	200	.0002	0001	
[illegible]	300	.0006	,0003	
[illegible]	400	.0014	.0007	
	600	0035	.0020	
	800	.0060	.0035	
	1,000	.0099	.0065	
	1,200	.0145	.0101	
	1,400	.0210	.0159	First crack.
	1,600	.0328	.0252	
	1,800	.0428	.0327	
	1,931	.0690	....	Ultimate strength.

TABLE No. 12.

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 29.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

APPLIED LOADS		IN GAUGED LENGTH.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0004	0	
57,840	400	.0007	.0001	
86,760	600	.0013	.0002	
115,680	800	.0019	.0004	
144,600	1,000	.0027	.0006	
173,520	1,200	.0037	.0009	
202,440	1,400	.0047	.0012	
231,360	1,600	.0061	.0016	
260,280	1,800	.0076	.0020	
289,200	2,000	.0095	.0030	
318,120	2,200	.0118	.0039	
347,040	2,400	.0135	.0050	
375,960	2,600	.0152	.0062	
404,880	2,800	.0167	.0072	First crack.
433,800	3,000	.0173	.0077	Micrometer disturbed.
462,720	3,200	.0177	.0081	
491,640	3,400	.0207	.0090	
520,560	3,600	.0222	.0097	
549,480	3,800	.0239	.0106	
578,400	4,000	.0260	.0116	
607,320	4,200	.0280	.0120	
636,240	4,400	.0343	.0141	
648,000	4,481	....	....	Ultimate strength.

MARKS, 34.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

14,436	100	0	0	Initial load.
28,872	200	.0003	.0001	
43,308	300	.0007	.0001	
57,744	400	.0011	.0002	
86,616	600	.0019	.0004	
115,488	800	.0027	.0008	
144,360	1,000	.0038	.0012	
173,232	1,200	.0049	.0016	
202,104	1,400	.0062	.0022	
230,976	1,600	.0079	.0029	
259,848	1,800	.0099	.0038	
288,720	2,000	.0124	.0052	
317,592	2,200	.0153	.0068	
346,464	2,400	.0178	.0084	
375,336	2,600	.0210	.0104	First crack.
404,208	2,800	.0240	.0124	
433,080	3,000	.0269	.0143	
461,952	3,200	.0298	.0162	
490,824	3,400	.0333	.0186	
519,616	3,600	.0364	.0203	
548,568	3,800	.0398	.0228	
577,440	4,000	.0435	.0252	
651,000	4,510	....	....	Ultimate strength.

TABLE No. 11—(*Concluded*).

Compression Tests of Concrete Cubes Made of Genesee Cement.

MARKS, 28.

Sectional area, 145.20 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

APPLIED LOADS.		IN GAUGED LENGTH.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,520	100	0	0	Initial load.
29,040	200	.0002	.0001	
43,560	300	.0006	,0003	
58,080	400	.0014	.0007	
87,120	600	.0035	.0020	
116,160	800	.0060	.0035	
145,200	1,000	.0099	.0065	
174,240	1,200	.0145	.0101	
203,280	1,400	.0210	.0153	First crack.
232,320	1,600	.0328	.0252	
261,360	1,800	.0428	.0327	
280,400	1,931	.0590	....	Ultimate strength.

TABLE No. 12.

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 29.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

APPLIED LOADS		IN GAUGED LENGTH.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0004	0	
57,840	400	.0007	.0001	
86,760	600	.0013	.0002	
115,680	800	.0019	.0004	
144,600	1,000	.0027	.0006	
173,520	1,200	.0037	.0009	
202,440	1,400	.0047	.0012	
231,360	1,600	.0061	.0016	
260,280	1,800	.0076	.0020	
289,200	2,000	.0095	.0030	
318,120	2,200	.0113	.0039	
347,040	2,400	.0135	.0050	
375,960	2,600	.0152	.0062	
404,880	2,800	.0167	.0072	First crack.
433,800	3,000	.0173	.0077	Micrometer disturbed.
462,720	3,200	.0177	.0081	
491,640	3,400	.0207	.0090	
520,560	3,600	.0222	.0097	
549,480	3,800	.0239	.0106	
578,400	4,000	.0260	.0116	
607,320	4,200	.0280	.0120	
636,240	4,400	.0343	.0141	
648,000	4,481	....	....	Ultimate strength.

MARKS, 34.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,436	100	0	0	Initial load.
28,872	200	.0003	.0001	
43,308	300	.0007	.0001	
57,744	400	.0011	.0002	
86,616	600	.0019	.0004	
115,488	800	.0027	.0008	
144,360	1,000	.0038	.0012	
173,232	1,200	.0049	.0016	
202,104	1,400	.0062	.0022	
230,976	1,600	.0079	.0029	
259,848	1,800	.0099	.0038	
288,720	2,000	.0124	.0052	
317,592	2,200	.0153	.0068	
346,464	2,400	.0178	.0084	
375,336	2,600	.0210	.0104	First crack.
404,208	2,800	.0240	.0124	
433,080	3,000	.0269	.0143	
461,952	3,200	.0298	.0162	
490,824	3,400	.0333	.0186	
519,616	3,600	.0364	.0203	
548,568	3,800	.0398	.0228	
577,440	4,000	.0435	.0252	
651,000	4,510	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 39.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,532	100	0	0	Initial load.
29 064	200	.0002	0	
43,596	300	.0006	.0001	
58,128	400	.0009	.0002	
87 192	600	.0017	.0003	
116,256	800	.0025	.0007	
145,320	1,000	.0037	.0012	
174,384	1,200	.0050	.0017	
203,448	1,400	.0064	.0024	
232,512	1,600	.0086	.0035	
261,576	1,800	.0109	.0047	
290,640	2,000	.0132	.0061	
319,704	2,200	.0157	.0077	
348,768	2,400	.0185	.0094	First crack.
377,832	2,600	.0213	.0112	
406,896	2,800	.0242	.0133	
435,960	3,000	.0272	.0155	
465,024	3,200	.0308	.0182	
494,088	3,400	.0338	.0214	
618,000	4,253	....	....	Ultimate strength.

MARKS, 39a.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0004	.0001	
43,236	300	.0009	.0003	
57,648	400	.0014	.0005	
72,060	500	.0020	.0008	
86,472	600	.0027	.0011	
100,884	700	.0035	.0014	
115,296	800	.0043	.0017	
129,708	900	.0053	.0023	
144,120	1,000	.0062	.0028	
158,532	1,100	.0075	.0035	
172,944	1,200	.0085	.0041	
187,356	1,300	.0098	.0049	
201,000	....	....	....	First crack.
201,768	1,400	.0109	.0056	
216,180	1,500	.0120	.0063	
230,592	1,600	.0135	.0076	
245,004	1,700	.0145	.0083	
259,416	1,800	.0155	.0088	
273,828	1,900	.0168	.0097	
288,240	2,000	.0183	.0109	
302,652	2,100	.0196	.0117	
317,064	2,200	.0212	.0130	
331,476	2,300	.0231	.0144	
345,888	2,400	.0247	.0155	
360,300	2,500	.0268	.0172	
374,712	2,600	.0289	.0187	
492,500	3,417	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 30.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,472	100	0	0	Initial load.
28,944	200	.0002	0	
43,416	300	.0005	.0001	
57,888	400	.0009	.0001	
86,832	600	.0016	.0004	
115,776	800	.0025	.0008	
144,720	1,000	.0035	.0012	
173,664	1,200	.0050	.0019	
202,608	1,400	.0066	.0027	
231,552	1,600	.0089	.0040	
260,496	1,800	.0117	.0058	
289,440	2,000	.0146	.0079	
318,384	2,200	.0176	.0097	First crack.
347,328	2,400	.0208	.0114	
376,272	2,600	.0230	.0130	
405,216	2,800	.0257	.0147	
434,160	3,000	.0289	.0165	
487,400	3,368	....	....	Ultimate strength.

MARKS, 35.

Sectional area, 144.00 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,400	100	0	0	Initial load.
28,800	200	.0001	0	
43,200	300	.0004	0	
57,600	400	.0006	0	
86,400	600	.0011	.0002	
115,200	800	.0019	.0005	
144,000	1,000	.0029	.0009	
172,800	1,200	.0042	.0015	
201,600	1,400	.0057	.0024	
230,400	1,600	.0074	.0033	
259,200	1,800	.0093	.0045	
288,000	2,000	.0117	.0062	
316,800	2,200	.0143	.0080	
345,600	2,400	.0173	.0101	First crack.
374,400	2,600	.0202	.0121	
403,200	2,800	.0230	.0140	
432,000	3,000	.0258	.0161	
451,000	3,182	....	....	Ultimate strength.

MARKS, 40.

Sectional area, 144.00 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,400	100	0	0	Initial load.
28,800	200	.0002	0	
43,200	300	.0005	.0001	
57,600	400	.0009	.0003	
86,400	600	.0017	.0005	
115,200	800	.0026	.0009	
144,000	1,000	.0039	.0014	
172,800	1,200	.0054	.0022	
201,600	1,400	.0076	.0035	
230,400	1,600	.0103	.0049	
259,200	1,800	.0132	.0068	
288,000	2,000	.0162	.0087	First crack.
316,800	2,200	.0207	.0119	
345,600	2,400	.0244	.0146	
374,400	2,600	.0286	.0173	
455,600	3,164	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 31.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0005	.0001	
57,840	400	.0008	.0002	
86,760	600	.0017	.0007	
115,680	800	.0028	.0013	
144,600	1,000	.0043	.0021	
173,520	1,200	.0062	.0033	
202,440	1,400	.0086	.0049	
231,360	1,600	.0114	.0067	First crack.
260,280	1,800	.0152	.0096	
289,200	2,000	.0202	.0138	
306,000	2,116	.0330	....	Ultimate strength.

MARKS, 36.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,436	100	0	0	Initial load.
28,872	200	0002	.0001	
43,308	300	.0006	.0002	
57,744	400	.0010	.0004	
72,180	500	.0015	.0006	
86,616	600	.0020	.0008	
101,052	700	.0028	.0012	
115,488	800	.0035	.0015	
129,924	900	.0044	.0021	
144,360	1,000	.0053	.0026	
158,796	1,100	.0064	.0033	
173,232	1,200	.0074	.0039	
187,668	1,300	.0086	.0048	
202,104	1,400	.0098	.0057	
216,540	1,500	.0108	.0063	
230,976	1,600	.0123	.0077	
245,412	1,700	.0147	.0086	
259,848	1,800	.0150	.0097	First crack.
274,284	1,900	.0159	.0102	
288,720	2,000	.0171	.0110	
303,156	2,100	.0181	.0118	
317,592	2,200	.0199	.0130	
332,028	2,300	.0218	.0145	
346,464	2,400	.0238	.0157	
360,900	2,500	.0250	.0166	
375,336	2,600	.0267	.0174	
389,772	2,700	.0293	.0189	
401,500	2,781	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 41.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

APPLIED LOADS.		IN GAUGED LENGTH.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,436	100	0	0	Initial load.
28,872	200	.0004	.0001	
43,308	300	.0011	.0005	
57,744	400	.0020	.0010	
86,616	600	.0039	.0022	
115,488	800	.0065	.0043	
144,360	1,000	.0096	.0065	
173,232	1,200	.0131	.0092	
202,104	1,400	.0155	.0110	First crack.
230.976	1,600	.0183	.0128	
259,848	1,800	.0215	.0147	
288,720	2,000	.0234	.0153	
294,100	2,037	....	....	Ultimate strength.

MARKS, 32.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,472	100	0	0	Initial load.
28,944	200	.0004	.0002	
43,416	300	.0010	.0005	
57,888	400	.0018	,0013	
86,832	600	.0039	.0024	
115,776	800	.0070	.0045	
144,720	1,000	.0113	.0080	
173,664	1,200	.0158	.0112	
202,608	1,400	.0210	.0152	First crack.
231,552	1,600	.0281	.0205	
260,496	1,800	.0363	.0262	
271,000	1,873	....	....	Ultimate strength.

MARKS, 37.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0005	.0003	
43,380	300	.0014	.0009	
57,840	400	.0033	.0022	
72,300	500	.0051	.0036	
86,760	600	.0075	.0055	
101,220	700	.0095	.0072	
115,680	800	.0118	.0091	
130,140	900	.0146	.0111	
144,000	....	....	....	First crack.
144,600	1,000	.0172	.0134	
159,060	1,100	.0204	.0157	
173,520	1,200	.0245	.0189	
187,980	1,300	.0278	.0216	
202,440	1,400	.0314	.0245	
254,600	1,761	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 42.

Sectional area, 145.20 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,520	100	0	0	Initial load.
29,040	200	.0002	.0001	
43,560	300	.0007	.0008	
58,080	400	.0015	.0008	
87,120	600	.0035	.0020	
116,160	800	.0064	.0040	
145,200	1,000	.0100	.0070	
174,240	1,200	.0137	.0097	First crack.
203,280	1,400	.0168	.0119	
232,320	1,600	.0208	.0149	
261,360	1,800	.0217	.0143	
278,300	1,917	.0196	....	Ultimate strength.

MARKS, 33.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0007	.0004	
43,272	300	.0016	.0011	
57,696	400	.0026	.0017	
86,544	600	.0055	.0038	
115,392	800	.0084	.0060	
144,240	1,000	.0110	.0080	
173,088	1,200	.0145	.0106	First crack.
201,936	1,400	.0175	.0126	
230 784	1,600	.0214	.0150	
259.632	1,800	.0255	.0177	
282,600	1,959	.0317	....	Ultimate strength.

MARKS, 38.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0006	.0004	
43,236	300	.0019	.0014	
57,648	400	.0036	.0027	
72,060	500	.0056	.0042	
86,472	600	.0081	.0065	
100,884	700	.0102	.0080	
115,296	800	.0135	.0106	
129,708	900	.0179	.0143	
144,120	1,000	.0200	.0157	
158,000	....	....	....	First crack.
158,532	1,100	.0233	.0181	
172,944	1,200	.0273	.0214	
187,356	1,300	.0317	.0248	
201,768	1,400	.0374	....	
216,180	1,500	.0424	....	
246,500	1,710	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 43.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,472	100	0	0	Initial load.
28,944	200	.0004	0	
43,416	300	.0020	.0013	
57,888	400	.0039	.0030	
86,832	600	.0078	.0058	
115,776	800	.0125	.0096	
144,720	1,000	.0176	.0136	First crack.
173,664	1,200	.0230	.0173	
202,608	1,400	.0311	.0229	
212,700	1,470	....	....	Ultimate strength.

MARKS, 44.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,272	300	.0003	0	
57,696	400	.0005	0	
86,544	600	.0010	.0001	
115,392	800	.0016	.0002	
144,240	1,000	.0024	.0004	
173,088	1,200	.0035	.0008	
201,936	1,400	.0048	.0013	
230,784	1,600	.0067	.0020	
259,632	1,800	.0088	.0030	
288,480	2,000	.0108	.0042	
317,328	2,200	.0130	.0055	
346,176	2,400	.0147	.0067	
375,024	2,600	.0163	.0077	
403,872	2,800	.0181	.0087	
432,720	3,000	.0205	.0100	First crack.
461,568	3,200	.0228	.0116	
470,416	3,400	.0241	.0123	
613,400	4,252	....	....	Ultimate strength.

MARKS, 49.

Sectional area, 144.00 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,400	100	0	0	Initial load.
28,800	200	.0000	0	
43,200	300	.0000	0	
57,600	400	.0001	0	
86,400	600	.0006	0	
115,200	800	.0012	.0001	
144,000	1,000	.0020	.0002	
172,800	1,200	.0029	.0004	
201,600	1,400	.0039	.0007	
230,400	1,600	.0051	.0011	
259,200	1,800	.0065	.0016	
288,000	2,000	.0083	.0024	
316,800	2,200	.0104	.0034	
345,600	2,400	.0124	.0043	
374,400	2,600	.0146	.0056	
403,200	2,800	.0170	.0068	First crack.
432,000	3,000	.0189	.0081	
460,800	3,200	.0211	.0094	
489,600	3,400	.0236	.0111	
518,400	3,600	.0256	.0121	
642,600	4,462	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 54.

Sectional area, 144.00 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,400	100	0	0	Initial load.
28,800	200	.0002	0	
43,200	300	.0005	.0001	
57,600	400	.0009	.0001	
86,400	600	.0015	.0004	
115,200	800	.0022	.0006	
144,000	1,000	.0031	.0009	
172,800	1,200	.0044	.0013	
201,600	1,400	.0058	.0019	
230,400	1,600	.0076	.0027	
259,200	1,800	.0097	.0040	
288,000	2,000	.0119	.0052	
316,800	2,200	.0139	.0074	First crack.
345,600	2,400	.0168	.0102	
374,400	2,600	.0202	.0122	
403,200	2,800	.0248	.0146	
432,000	3,000	.0300	.0181	
460,800	3,200	.0397	.0249	
486,600	3,379	.0495	....	Ultimate strength.

MARKS, 45.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0006	.0001	
57,840	400	.0009	.0002	
86,760	600	.0017	.0005	
115,680	800	.0026	.0008	
144,600	1,000	.0036	.0012	
173,520	1,200	.0050	.0017	
202,440	1,400	.0068	.0027	
231,360	1,600	.0091	.0039	
260,280	1,800	.0108	.0048	
289,200	2,000	.0135	.0066	
318,120	2,200	.0157	.0081	
347,040	2,400	.0180	.0095	First crack.
375,960	2,600	.0207	.0111	
404,880	2,800	.0234	.0128	
433,800	3,000	.0255	.0140	
448,260	3,100	.0266	.0144	
462,720	3,200	.0272	.0146	
477,180	3,300	.0278	.0146	
533,000	3,686	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 50.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length, Compression. Inch.	In Gauged Length, Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,272	300	.0004	0	
57,696	400	.0007	.0001	
86,544	600	.0013	.0002	
115,392	800	.0021	.0006	
144,240	1,000	.0031	.0010	
173,088	1,200	.0042	.0015	
201,936	1,400	.0054	.0022	
230,784	1,600	.0069	.0031	
259,632	1,800	.0085	.0040	
288,480	2,000	.0102	.0049	
317,328	2,200	.0119	.0059	
346,176	2,400	.0130	.0070	First crack.
375,024	2,600	.0140	.0078	
403,872	2,800	.0153	.0090	
432,720	3,000	.0179	.0113	
461,568	3,200	.0217	.0141	
484,500	3,359	....	....	Ultimate strength.
MARKS, 55.				
Sectional area, 144.00 square inches. Gauged length, 5 inches.				
14,400	100	0	0	Initial load.
28,800	200	.0001	0	
43,200	300	.0003	0	
57,600	400	.0006	0	
86,400	600	.0013	.0003	
115,200	800	.0024	.0008	
144,000	1,000	.0037	.0014	
172,800	1,200	.0053	.0021	
201,600	1,400	.0076	.0033	
230,400	1,600	.0100	.0046	
255,000	....	....	....	First crack.
259,200	1,800	.0124	.0061	
288,000	2,000	.0150	.0080	
316,800	2,200	.0177	.0095	
345,600	2,400	.0198	.0112	
374,400	2,600	.0214	.0123	
403,200	2,800	.0248	.0150	
432,000	3,000	.0286	.0177	
460,800	3,200	.0336	.0213	
482,600	3,351	....	....	Ultimate strength.
MARKS, 46.				
Sectional area, 144.60 square inches. Gauged length, 5 inches.				
14,460	100	0	0	Initial load.
28,920	200	.0003	.0001	
43,380	300	.0007	.0002	
57,840	400	.0011	.0004	
86,760	600	.0022	.0010	
115,680	800	.0038	.0020	
144,600	1,000	.0056	.0031	
173,520	1,200	.0083	.0049	
202,440	1,400	.0117	.0074	
231,360	1,600	.0154	.0102	
260,280	1,800	.0203	.0139	First crack.
289,200	2,000	.0266	.0190	
328,500	2,272	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 51.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch	Compression. Inch.	Set. Inch.	
14,472	100	0	0	Initial load.
28,944	200	.0003	.0001	
43,416	300	.0009	.0003	
57,888	400	.0016	.0008	
72,360	500	.0024	.0013	
86,832	600	.0033	.0019	
101,304	700	.0045	.0028	
115,776	800	.0058	.0037	
130,248	900	.0072	.0046	
144,720	1,000	.0088	.0058	
159,192	1,100	.0110	.0076	
173,664	1,200	.0130	.0090	
188,136	1,300	.0155	.0108	
202,608	1,400	.0179	.0127	
217,080	1,500	.0215	.0157	
231,552	1,600	.0244	.0180	First crack.
246,024	1,700	.0276	.0203	
260,496	1,800	.0314	.0236	
274,968	1,900	.0364	.0274	
289,440	2,000	.0424	.0320	
303,912	2,100	.0494	.0382	
322,800	2,230	....	....	Ultimate strength.

MARKS, 56.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0003	.0001	
43,236	300	.0009	.0003	
57,648	400	.0014	.0007	
72,060	500	.0021	.0011	
86,472	600	.0030	.0015	
100,884	700	.0041	.0023	
115,296	800	.0056	.0033	
129,708	900	.0071	.0042	
144,120	1,000	.0087	.0054	
158,532	1,100	.0107	.0070	
170,000	....	....	....	First crack.
172,944	1,200	.0126	.0085	
187,356	1,300	.0146	.0098	
201,768	1,400	.0168	.0115	
216,180	1,500	.0189	.0130	
230,592	1,600	.0208	.0143	
245,004	1,700	.0229	.0159	
259,416	1,800	.0252	.0174	
273,828	1,900	.0280	.0193	
288,240	2,000	.0315	.0214	
302,652	2,100	.0365	.0243	
315,200	2,187	....	....	Ultimate strength.

TABLE No. 12—(*Continued*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 47.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0006	.0003	
43,380	300	.0014	.0007	
57,840	400	.0024	.0013	
86,760	600	.0045	.0026	
115,680	800	.0068	.0041	
144,600	1,000	.0095	.0057	
173,520	1,200	.0128	.0083	
202,440	1,400	.0170	.0111	First crack.
231,360	1,600	.0217	.0145	
260,280	1,800	.0237	....	
271,800	1,880	....	....	Ultimate strength.

MARKS, 52.

Sectional area, 144.96 square inches. Gauged length, 5 inches.

14,496	100	0	0	Initial load.
28,992	200	.0008	.0004	
43,488	300	.0018	.0012	
57,984	400	.0032	.0022	
86,976	600	.0064	.0047	
115,968	800	.0101	.0073	
144,960	1,000	.0144	.0106	
173,952	1,200	.0196	.0145	
190,000	....	....	....	First crack.
202,944	1,400	.0257	.0194	
231,936	1,600	.0338	.0264	
258,200	1,781	....	....	Ultimate strength.

MARKS, 57.

Sectional area, 144.96 square inches. Gauged length, 5 inches.

14,496	100	0	0	Initial load.
28,992	200	.0005	.0003	
43,488	300	.0014	.0009	
57,984	400	.0021	.0013	
86,976	600	.0049	.0033	
115,968	800	.0086	.0060	
144,960	1,000	.0128	.0093	
173,952	1,200	.0169	.0124	
202,944	1,400	.0212	.0155	First crack.
231,936	1,600	.0272	.0200	
260,928	1,800	.0322	.0225	
271,000	1,869	....	....	Ultimate strength.

MARKS, 48.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

14,412	100	0	0	Initial load.
28,824	200	.0005	.0002	
43,236	300	.0014	.0008	
57,648	400	.0025	.0015	
86,472	600	.0057	.0039	
115,296	800	.0098	.0069	
141,120	1,000	.0137	.0098	
172,944	1,200	.0200	.0147	
201,768	1,400	.0282	.0212	First crack.
264,000	1,832	....	....	Ultimate strength.

TABLE No. 12—(*Concluded*).

Compression Tests of Concrete Cubes Made of Wayland Cement.

MARKS, 58.

Sectional area, 144.84 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,484	100	0	0	Initial load.
28,968	200	.0007	.0004	
43,452	300	.0016	.0011	
57,936	400	.0028	.0018	
86,904	600	.0062	.0042	
115,872	800	.0100	.0072	First crack.
144,840	1,000	.0147	.0106	
173,808	1,200	.0198	.0147	
202,776	1,400	.0260	.0191	
231,744	1,600	.0346	.0245	
236,200	1,631	.0357	....	Ultimate strength.

MARKS, 58.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0009	.0006	
43,236	300	.0021	.0015	
57,648	400	.0039	.0028	
86,472	600	.0082	.0063	
115,296	800	.0133	.0103	
144,120	1,000	.0191	.0148	
169,000	....	....	....	First crack.
172,944	1,200	.0267	.0208	
201,768	1,400	.0367	.0289	
230,592	1,600	.0471	.0380	
245,700	1,705	.0524	....	Ultimate strength.

TABLE No. 13.

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 59.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,448	100	0	0	Initial load.
28,896	200	.0001	0	
43,344	300	.0004	.0001	
57,792	400	.0007	.0001	
86,688	600	.0013	.0003	
115,584	800	.0021	.0006	
144,480	1,000	.0029	.0010	
173,376	1,200	.0041	.0016	
202,272	1,400	.0058	.0024	
231,168	1,600	.0077	.0035	
260,064	1,800	.0102	.0053	
288,960	2,000	.0124	.0066	
317,856	2,200	.0151	.0085	
346,752	2,400	.0183	.0107	
375,648	2,600	.0230	.0142	First crack.
404,544	2,800	.0265	.0163	
433,440	3,000	.0326	.0207	
462,336	3,200	.0430	.0324	
474,300	3,283	....	....	Ultimate strength.
		MARKS, 62.		
		Sectional area, 144.48 square inches. Gauged length, 5 inches.		
14,448	100	0	0	Initial load.
28,896	200	.0001	0	
43,344	300	.0003	0	
57,792	400	.0005	.0001	
72,240	500	.0009	.0002	
86,688	600	.0012	.0003	
101,136	700	.0014	.0004	
115,584	800	.0018	.0006	
130,032	900	.0023	.0008	
144,480	1,000	.0028	.0010	
158,928	1,100	.0036	.0012	
173,376	1,200	.0041	.0015	
187,824	1,300	.0052	.0020	
202,272	1,400	.0064	.0027	
216,720	1,500	.0077	.0035	
231,168	1,600	.0091	.0043	
245,616	1,700	.0105	.0053	
260,064	1,800	.0128	.0069	
270,000	....	....	....	First crack.
274,512	1,900	.0145	.0081	
288,960	2,000	.0166	.0095	
303,408	2,100	.0191	.0114	
317,856	2,200	.0211	.0128	
332,304	2,300	.0240	.0148	
346,752	2,400	.0269	.0170	
361,200	2,500	.0309	.0200	
416,300	2,881	....	....	Ultimate strength.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 62a.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,448	100	0	0	Initial load.
28,896	200	.0002	0	
43,344	300	.0005	.0001	
57,792	400	.0009	.0002	
72,240	500	.0016	.0005	
86,688	600	.0023	.0008	
101,136	700	.0032	.0014	
115,584	800	.0043	.0022	
130,032	900	.0056	.0030	
144,480	1,000	.0068	.0038	
158,928	1,100	.0081	.0046	
173,376	1,200	.0093	.0055	
187,824	1,300	.0106	.0063	
201,000	....	....	....	First crack.
202,272	1,400	.0120	.0073	
216,720	1,500	.0134	.0085	
14,448	100	....	.0088	After 2 minutes.
28,896	200	.0088	....	
43,344	300	.0092	....	
57,792	400	.0097	....	
72,240	500	.0101	....	
86,688	600	.0105	....	
101,136	700	.0109	....	
115,584	800	.0112	....	
130,032	900	.0116	....	
144,480	1,000	.0119	....	
130,032	900	.0117	....	
115,584	800	.0115	....	
101,136	700	.0113	....	
86,688	600	.0111	....	
72,240	500	.0108	....	
57,792	400	.0104	....	
43,344	300	.0100	....	
28,896	200	.0094	....	
14,448	100	....	.0086	
......	100	....	.0085	After 5 minutes.
231,168	1,600	.0147	.0094	
245,616	1,700	.0155	.0099	
260,064	1,800	.0163	.0103	
274,512	1,900	.0178	.0109	
288,960	2,000	.0191	.0117	
327,200	2,265	....	....	Ultimate strength.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 65.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

APPLIED LOADS.		IN GAUGED LENGTH.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,412	100	0	0	Initial load.
28,824	200	.0001	0	
43,236	300	.0002	0	
57,648	400	.0004	0	
86,472	600	.0009	.0001	
115,296	800	.0015	.0004	
144,120	1,000	.0023	.0007	
172,944	1,200	.0038	.0015	
201,768	1,400	.0056	.0023	
230,592	1,600	.0078	.0037	
259,416	1,800	.0110	.0060	
288,240	2,000	.0151	.0089	First crack.
317,064	2,200	.0194	.0119	
345,888	2,400	.0247	.0161	
374,712	2,600	.0362	.0252	
403,536	2,800	.0480	.0348	
429,400	2,979	....	....	Ultimate strength.

MARKS, 60.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

14,532	100	0	0	Initial load.
29,064	200	.0000	0	
43,596	300	.0004	.0001	
58,128	400	.0012	.0005	
87,192	600	.0036	.0021	
116,256	800	.0073	.0049	
145,320	1,000	.0135	.0099	
174,384	1,200	.0207	.0158	
202,000	....	....	....	First crack.
203,448	1,400	.0310	.0249	
270,800	1,863	....	....	Ultimate strength.

MARKS, 63.

Sectional area, 145.68 square inches. Gauged length, 5 inches.

14,568	100	0	0	Initial load.
29,136	200	.0001	0	
43,704	300	.0003	0	
58,272	400	.0008	.0001	
87,408	600	.0022	.0009	
116,544	800	.0051	.0026	
145,680	1,000	.0106	.0069	
172,000	....	....	....	First crack.
174,816	1,200	.0183	.0139	
203,952	1,400	.0320	.0250	
233,088	1,600	.0510	.0394	
291,500	2,001	....	....	Ultimate strength.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 66.

Sectional area, 145.56 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,556	100	0	0	Initial load.
29,112	200	.0002	0	
43,668	300	.0006	.0002	
58,224	400	.0012	.0006	
72,780	500	.0020	.0011	
87,336	600	.0033	.0018	
101,892	700	.0051	.0032	
116,448	800	.0071	.0045	
131,004	900	.0096	.0065	
145,560	1,000	.0126	.0089	
160,116	1,100	.0166	.0123	First crack.
174,672	1,200	.0210	.0159	
189,228	1,300	.0251	.0191	
203,784	1,400	.0305	.0235	
218,340	1,500	.0350	.0270	
......	....	....	.0266	After ½ minute.
29,112	200	.0274	....	
58,224	400	.0292	....	
87,336	600	.0308	....	
116,448	800	.0320	....	
145,560	1,000	.0331	....	
174,672	1,200	.0341	....	
203,784	1,400	.0356	....	
174,672	1,200	.0354	....	
145,560	1,000	.0349	....	
116,448	800	.0343	....	
87,336	600	.0336	....	
58,224	400	.0324	....	
29,112	200	.0305	.0284	
......	....	....	.0282	After ½ minute.
279,300	1,919	....	....	Ultimate strength.

MARKS, 61.

Sectional area, 145.80 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,580	100	0	0	Initial load.
29,160	200	.0013	.0010	
43,740	300	.0032	.0025	
58,320	400	.0051	.0041	
87,480	600	.0099	.0080	
116,640	800	.0157	.0128	
145,800	1,000	.0221	.0181	First crack.
174,960	1,200	.0282	.0231	
204,120	1,400	.0365	.0297	
232,200	1,593	....	....	Ultimate strength.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 64.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,448	100	0	0	Initial load.
28,896	200	.0006	.0004	
43,344	300	.0013	.0009	
57,792	400	.0025	.0016	
72,240	500	.0038	.0028	
86,688	600	.0056	.0040	
101,136	700	.0078	.0059	
115,584	800	.0100	.0075	
130,032	900	.0126	.0097	
144,480	1,000	.0160	.0123	
158,920	1,100	.0194	.0150	
173,376	1,200	.0225	.0174	
187,824	1,300	.0273	.0212	
202,272	1,400	.0318	.0248	
216,720	1,500	.0389	.0310	First crack.
231,168	1,600	.0473	.0379	
261,300	1,809	....	....	Ultimate strength.
		MARKS, 67.		
		Sectional area, 145.20 square inches. Gauged length, 5 inches.		
14,520	100	0	0	Initial load.
29,040	200	.0005	.0002	
43,560	300	.0012	.0008	
58,080	400	.0020	.0014	
87,120	600	.0050	.0035	
116,160	800	.0090	.0066	
145,200	1,000	.0144	.0110	
172,000	....	....	....	First crack.
174,240	1,200	.0211	.0166	
203,280	1,400	.0302	.0244	
232,320	1,600	.0445	.0371	
267,300	1,841	....	....	Ultimate strength.
		MARKS, 67a.		
		Sectional area, 144.60 square inches. Gauged length, 5 inches.		
14,460	100	0	0	Initial load.
28,920	200	.0010	.0006	
43,380	300	.0025	.0019	
57,840	400	.0048	.0037	
72,300	500	.0077	.0061	
86,760	600	.0111	.0088	
101,220	700	.0148	.0119	
115,680	800	.0188	.0152	First crack.
130,140	900	.0231	.0188	
144,600	1,000	.0278	.0228	
204,700	1,416	....	....	Ultimate strength.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 68.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks
Total pounds.	Pounds per square inch.	Compression. Inch.	Set Inch.	
14,460	100	0	0	Initial load.
28,920	200	.0001	0	
43,380	300	.0002	0	
57,840	400	.0004	0	
86,760	600	.0008	0	
115,680	800	.0012	.0001	
144,600	1,000	.0017	.0002	
173,520	1,200	.0023	.0005	
202,440	1,400	.0030	.0007	
231,360	1,600	.0038	.0011	
260,280	1,800	.0046	.0013	
289,200	2,000	.0057	.0017	
318,120	2,200	.0066	.0021	
347,040	2,400	.0078	.0026	
375,960	2,600	.0090	.0032	
404,880	2,800	.0105	.0040	
433,800	3,000	.0124	.0050	First crack.
462,720	3,200	.0146	.0064	
491,640	3,400	.0170	.0078	
520,560	3,600	.0213	.0104	
549,480	3,800	.0270	.0141	
578,400	4,000	.0450	.0253	Ultimate strength.

MARKS, 71.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,272	300	.0002	0	
57,696	400	.0004	0	
86,544	600	.0008	.0001	
115,392	800	.0013	.0001	
144,240	1,000	.0018	.0003	
173,088	1,200	.0024	.0005	
201,936	1,400	.0031	.0007	
230,784	1,600	.0040	.0011	
259,632	1,800	.0048	.0014	
288,480	2,000	.0058	.0018	
317,328	2,200	.0068	.0022	
346,176	2,400	.0080	.0028	
375,024	2,600	.0091	.0033	
403,872	2,800	.0104	.0041	
432,720	3,000	.0121	.0048	First crack.
461,568	3,200	.0143	.0060	
490,416	3,400	.0174	.0078	
519,264	3,600	.0209	.0096	Ultimate strength.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 74.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0000	0	
43,380	300	.0001	0	
57,840	400	.0003	0	
86,760	600	.0008	0	
115,680	800	.0014	.0001	
144,600	1,000	.0020	.0004	
173,520	1,200	.0029	.0007	
202,440	1,400	.0037	.0011	
231,360	1,600	.0049	.0015	
260,280	1,800	.0062	.0021	
289,200	2,000	.0082	.0032	
318,120	2,200	.0107	.0046	
347,040	2,400	.0130	.0061	First crack.
375,960	2,600	.0166	.0083	
404,880	2,800	.0200	.0105	
433,800	3,000	.0249	.0139	
496,800	3,436	....	....	Ultimate strength.

MARKS, 69.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0002	0	
43,272	300	.0007	.0001	
57,696	400	.0012	.0003	
86,544	600	.0022	.0010	
115,392	800	.0038	.0018	
144,240	1,000	.0060	.0033	
173,088	1,200	.0093	.0057	
201,936	1,400	.0133	.0091	
230,784	1,600	.0186	.0127	
259,632	1,800	.0258	.0189	First crack.
288,480	2,000	.0362	.0278	
313,000	2,170	....	....	Ultimate strength.

MARKS, 72.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,472	100	0	0	Initial load.
28,944	200	.0003	.0001	
43,416	300	.0008	.0003	
57,888	400	.0013	.0006	
86,832	600	.0026	.0013	
115,776	800	.0043	.0025	
144,720	1,000	.0064	.0040	
173,664	1,200	.0091	.0058	
202,608	1,400	.0118	.0077	
231,552	1,600	.0147	.0097	
245,000	....	....	....	First crack.
260,496	1,800	.0178	.0117	
289,440	2,000	.0215	.0145	
318,384	2,200	.0247	.0155	Ultimate strength.
				After determining the set the specimen failed while reapplying the load, the highest load then reached being 310,000 lbs.

TABLE No. 13—(*Continued*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 75.

Sectional area, 144.96 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,496	100	0	0	Initial load.
28,992	200	.0002	0	
43,488	300	.0005	.0001	
57,984	400	.0010	.0003	
86,976	600	.0019	.0009	
115,968	800	.0037	.0019	
144,960	1,000	.0061	.0035	
173,952	1,200	.0088	.0054	
202,944	1,400	.0115	.0074	
231,936	1,600	.0149	.0099	
260,928	1,800	.0185	.0125	First crack.
289,920	2,000	.0230	.0160	
318,912	2,200	.0285	.0204	
347,904	2,400	.0381	.0283	
365,000	2,518	....	....	Ultimate strength.
MARKS, 70. Sectional area, 146.05 square inches. Gauged length, 5 inches.				
14,605	100	0	0	Initial load.
29,210	200	.0002	0	
43,815	300	.0007	.0002	
58,420	400	.0013	.0006	
87,630	600	.0030	.0017	
116,840	800	.0052	.0034	
146,050	1,000	.0080	.0053	
175,260	1,200	.0115	.0080	
203,000	....	....	....	First crack.
204,470	1,400	.0159	.0113	
262,890	1,800	.0279	.0210	
297,000	2,034	....	....	Ultimate strength.
MARKS, 73. Sectional area, 145.56 square inches. Gauged length, 5 inches.				
14,556	100	0	0	Initial load.
29,112	200	.0003	.0001	
43,668	300	.0007	.0002	
58,224	400	.0012	.0004	
87,336	600	.0026	.0012	
116,448	800	.0045	.0024	
145,560	1,000	.0075	.0044	
174,672	1,200	.0117	.0074	
203,784	1,400	.0172	.0115	First crack.
232,896	1,600	.0240	.0169	
269,800	1,854	....	....	Ultimate strength.

TABLE No. 13—(*Concluded*).

Compression Tests of Concrete Cubes Made of Iron-Clad Cement.

MARKS, 76.

Sectional area, 145.68 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,568	100	0	0	Initial load.
29,136	200	.0005	.0001	
43,704	300	.0012	.0007	
58,272	400	.0022	.0013	
87,408	600	.0048	.0033	
116,544	800	.0087	.0062	
145,680	1,000	.0135	.0100	
174,816	1,200	.0205	.0157	
178,000	....	....	....	First crack.
203,952	1,400	.0285	.0223	
255,200	1,752	....	....	Ultimate strength.

TABLE No. 14.

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 77.

Sectional area, 145.44 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,544	100	0	0	Initial load.
29,088	200	.0003	.0001	
43,632	300	.0006	.0002	
58,176	400	.0009	.0003	
87,264	600	.0013	.0004	
116,352	800	.0020	.0006	
145,440	1,000	.0026	.0008	
174,528	1,200	.0033	.0010	
203,616	1,400	.0042	.0014	
232,704	1,600	.0051	.0018	
261,792	1,800	.0062	.0023	
290,880	2,000	.0072	.0025	
319,968	2,200	.0085	.0032	
349,056	2,400	.0097	.0037	
378,144	2,600	.0109	.0042	
407,232	2,800	.0127	.0050	
436,320	3,000	.0145	.0060	First crack.
465,408	3,200	.0168	.0072	
494,496	3,400	.0192	.0088	
523,584	3,600	.0220	.0106	
552,672	3,800	.0254	.0125	
581,760	4,000	.0300	.0150	
610,500	4,198	....	....	Ultimate strength.

MARKS, 80.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,236	300	.0002	0	
57,648	400	.0005	0	
86,472	600	.0012	.0001	
115,296	800	.0020	.0006	
144,120	1,000	.0031	.0012	
172,944	1,200	.0043	.0019	
201,768	1,400	.0061	.0030	
230,592	1,600	.0084	.0045	
259,416	1,800	.0110	.0062	
288,240	2,000	.0134	.0078	
317,064	2,200	.0172	.0104	
345,888	2,400	.0209	.0131	
374,712	2,600	.0260	.0170	
427,600	2,964	....	....	Ultimate strength.

TABLE No. 14—(*Continued*).

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 83.

Sectional area, 144.60 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,460	100	0	0	Initial load.
28,920	200	.0000	0	
43,380	300	.0001	0	
57,840	400	.0003	0	
86,760	600	.0008	.0001	
115,680	800	.0014	.0002	
144,600	1,000	.0021	.0004	
173,520	1,200	.0031	.0009	
202,440	1,400	.0043	.0014	
231,360	1,600	.0062	.0024	
260,280	1,800	.0084	.0037	
289,200	2,000	.0115	.0058	
318,120	2,200	.0148	.0080	
347,040	2,400	.0177	.0099	
375,960	2,600	.0213	.0125	First crack.
404,880	2,800	.0246	.0146	
433,800	3,000	.0285	.0172	
462,720	3,200	.0340	.0210	
491,640	3,400	.0520	.0333	Ultimate strength.

MARKS, 78.

Sectional area, 145.08 square inches. Gauged length, 5 inches.

14,508	100	0	0	Initial load.
29,016	200	0	0	
43,524	300	.0002	0	
58,032	400	.0004	0	
87,048	600	.0009	.0001	
116,064	800	.0015	.0003	
145,080	1,000	.0025	.0009	
174,096	1,200	.0035	.0012	
50,778	350	....	....	Rested under this load 16 hours.
14,508	100	....	.0014	Set after above rest.
203,112	1,400	.0049	.0022	
232,128	1,600	.0070	.0034	
261,144	1,800	.0095	.0050	
290,160	2,000	.0129	.0074	
319,176	2,200	.0183	.0116	First crack.
348,192	2,400	.0261	.0180	
377,208	2,600	.0372	.0266	
399,600	2,754	....	....	Ultimate strength.

MARKS, 81.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

14,532	100	0	0	Initial load.
29,064	200	.0001	0	
43,596	300	.0005	.0001	
58,128	400	.0009	.0003	
87,192	600	.0023	.0011	
116,256	800	.0046	.0026	
145,320	1,000	.0082	.0051	
174,384	1,200	.0121	.0082	
203,448	1,400	.0166	.0114	
232,512	1,600	.0215	.0152	First crack.
261,576	1,800	.0271	.0195	
290,640	2,000	.0344	.0250	
319,704	2,200	.0436	.0328	
344,800	2,373	....	....	Ultimate strength.

TABLE No. 14—(*Continued*).

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 84.

Sectional area, 144.60 square inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0007	.0002	
57,840	400	.0013	.0004	
86,760	600	.0030	.0015	
115,680	800	.0058	.0036	
144,600	1,000	.0098	.0066	
173,520	1,200	.0144	.0102	
202,440	1,400	.0195	.0141	
212,000	....	....	....	First crack.
231,360	1,600	.0271	.0203	
260,280	1,800	.0351	.0272	
289,200	2,000	.0457	.0353	
326,000	2,254	....	....	Ultimate strength.
				MARKS, 79.
				Sectional area, 144.84 square inches. Gauged length, 5 inches.
14,484	100	0	0	Initial load.
28,968	200	.0005	.0002	
43,452	300	.0011	.0006	
57,936	400	.0020	.0011	
86,904	600	.0040	.0026	
115,872	800	.0070	.0045	
144,840	1,000	.0097	.0064	
173,808	1,200	.0138	.0094	
202,776	1,400	.0195	.0140	First crack.
231,744	1,600	.0269	.0195	
260,712	1,800	.0329	.0322	
285,500	1,971	....	....	Ultimate strength.
				MARKS, 82.
				Sectional area, 145.68 square inches. Gauged length, 5 inches.
14,568	100	0	0	Initial load.
29,136	200	.0008	.0005	
43,704	300	.0019	.0012	
58,272	400	.0029	.0020	
87,408	600	.0059	.0041	
116,544	800	.0101	.0075	
145,680	1,000	.0146	.0108	
174,816	1,200	.0207	.0159	First crack.
203,952	1,400	.0277	.0212	
233,088	1,600	.0357	.0276	
262,224	1,800	.0493	.0387	
270,300	1,855	....	....	Ultimate strength.

TABLE No. 14—(*Continued*).

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 82c.

Sectional area, 146.17 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,617	100	0	0	
29,234	200	.0010	.0007	
43,851	300	.0022	.0016	
58,468	400	.0038	.0030	
73,085	500	.0062	.0046	
87,702	600	.0090	.0073	
102,319	700	.0125	.0100	
116,936	800	.0156	.0124	
131,553	900	.0191	.0153	First crack.
146,170	1,000	.0225	.0179	
160,787	1,100	.0250	.0195	
175,404	1,200	.0273	.0211	
190,021	1,300	.0263	.0190	Apparent compression nearly reached .03000", when the micrometer reversed its movement and returned to .0263".
204,638	1,400	.0273	.0177	
219,255	1,500	.0290	.0170	
223,600	1,530	....	....	Ultimate strength.
				Erratic movement of the micrometer during the final stages of the test, attributed to local yielding of the concrete.

MARKS, 85.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

14,532	100	0	0	Initial load.
29,064	200	.0005	.0002	
43,596	300	.0012	.0006	
58,128	400	.0020	.0012	
87,192	600	.0045	.0031	
116,256	800	.0093	.0068	
145,320	1,000	.0148	.0112	
174,384	1,200	.0206	.0158	First crack.
203,448	1,400	.0266	.0202	
232,512	1,600	.0341	.0254	
252,800	1,740	.0338	....	Ultimate strength.

TABLE No. 14—(*Continued*).

Compression Tests of Concrete Cubes Made of Empire Cement

MARKS, 86.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0002	0	
43,236	300	.0005	0	
57,648	400	.0007	.0001	
86,472	600	.0012	.0003	
115,296	800	.0019	.0005	
144,120	1,000	.0024	.0007	
172,944	1,200	.0031	.0010	
201,768	1,400	.0040	.0013	
230,592	1,600	.0047	.0019	
259,416	1,800	.0056	.0022	
288,240	2,000	.0065	.0026	
14,412	1,000	....	....	Rested under this load 16 hours.
....	....	....	.0036	Set after above rest.
317,064	2,200	.0080	.0038	
345,888	2,400	.0089	.0041	
374,712	2,600	.0101	.0046	
403,536	2,800	.0114	.0052	
432,360	3,000	.0132	.0062	
461,184	3,200	.0151	.0074	First crack.
490,008	3,400	.0178	.0090	
518,832	3,600	.0208	.0107	
547,656	3,800	.0255	.0142	
576,480	4,000	.0370	....	
588,500	4,083	....	....	Ultimate strength.

MARKS, 89.

Sectional area, 144.96 square inches. Gauged length, 5 inches.

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,496	100	0	0	Initial load.
28,992	200	.0001	0	
43,488	300	.0002	0	
57,984	400	.0005	0	
86,976	600	.0010	.0001	
115,968	800	.0016	.0002	
144,960	1,000	.0022	.0005	
173,952	1,200	.0030	.0008	
202,944	1,400	.0039	.0012	
231,936	1,600	.0052	.0018	
260,928	1,800	.0063	.0024	
289,920	2,000	.0082	.0034	
318,912	2,200	.0102	.0042	
347,904	2,400	.0122	.0056	
376,896	2,600	.0155	.0080	
405,888	2,800	.0187	.0099	
406,000	....	....	....	First crack.
434,880	3,000	.0231	.0132	
463,872	3,200	.0285	.0174	
537,000	3,704	....	....	Ultimate strength.

TABLE No. 14—(*Continued*).

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 92.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0002	0	
43,236	300	.0005	.0001	
57,648	400	.0007	.0002	
86,472	600	.0013	.0003	
115,296	800	.0021	.0007	
144,120	1,000	.0033	.0011	
172,944	1,200	.0043	.0016	
201,768	1,400	.0060	.0024	
230,592	1,600	.0082	.0037	
259,416	1,800	.0112	.0057	
288,240	2,000	.0145	.0080	
317,064	2,200	.0175	.0093	
345,888	2,400	.0200	.0113	
374,712	2,600	.0231	.0131	
403,536	2,800	.0267	.0160	
425,200	2,950	.0490	....	Ultimate strength.

MARKS, 87.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,532	100	0	0	Initial load.
29,064	200	.0002	0	
43,596	300	.0004	.0001	
58,128	400	.0006	.0001	
87,192	600	.0012	.0003	
116,256	800	.0019	.0006	
145,320	1,000	.0028	.0010	
174,384	1,200	.0038	.0014	
203,448	1,400	.0051	.0020	
232,512	1,600	.0067	.0028	
261,576	1,800	.0087	.0039	
290,640	2,000	.0115	.0060	
319,704	2,200	.0149	.0083	
348,768	2,400	.0207	.0127	
377,832	2,600	.0280	.0184	First crack.
406,896	2,800	.0380	.0263	
419,500	2,887	....	....	Ultimate strength.

MARKS, 90.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,448	100	0	0	Initial load.
28,896	200	.0003	0	
43,344	300	.0006	.0002	
57,792	400	.0010	.0004	
86,688	600	.0020	.0009	
115,584	800	.0033	.0017	
144,480	1,000	.0048	.0027	
173,376	1,200	.0074	.0044	
202,272	1,400	.0098	.0062	
228,000	....	....	....	First crack.
231,168	1,600	.0129	.0083	
260,064	1,800	.0163	.0106	
288,960	2,000	.0203	.0138	
317,856	2,200	.0243	.0168	
346,752	2,400	.0274	.0189	
372,500	2,578	....	....	Ultimate strength.

TABLE No. 14—(*Continued*).

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 93.

Sectional area, 144.84 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,484	100	0	0	Initial load.
28,968	200	.0001	0	
43,452	300	.0004	.0001	
57,936	400	.0006	.0002	
86,904	600	.0015	.0006	
115,872	800	.0031	.0015	
144,840	1,000	.0054	.0030	
173,808	1,200	.0080	.0048	
202,776	1,400	.0120	.0078	
231,744	1,600	.0159	.0106	
260,712	1,800	.0214	.0149	
275,000	....	....	....	First crack.
289,680	2,000	.0275	.0198	
314,500	2,171	.0375	....	Ultimate strength.
MARKS, 88. Sectional area, 144.72 square inches. Gauged length, 5 inches.				
14,472	100	0	0	Initial load.
28,944	200	.0001	0	
43,416	300	.0004	0	
57,888	400	.0007	.0001	
56,832	600	.0015	.0005	
115,776	800	.0025	.0009	
144,720	1,000	.0036	.0014	
173,664	1,200	.0057	.0026	
202,608	1,400	.0084	.0044	
231,552	1,600	.0121	.0074	
260,496	1,800	.0192	.0129	
285,000	....	....	....	First crack.
289,440	2,000	.0300	.0220	
300,100	2,074	.0570	....	Ultimate strength.
MARKS, 91. Sectional area, 144.48 square inches. Gauged length, 5 inches.				
14,448	100	0	0	Initial load.
28,896	200	.0002	0	
43,344	300	.0005	.0002	
57,792	400	.0010	.0005	
86,688	600	.0025	.0014	
115,584	800	.0045	.0028	
144,480	1,000	.0080	.0052	
173,376	1,200	.0118	.0082	
202,272	1,400	.0156	.0110	First crack.
231,168	1,600	.0209	.0153	
260,064	1,800	.0289	.0215	
288,960	2,000	.0400	....	Ultimate strength.

TABLE No. 14—(*Concluded*).

Compression Tests of Concrete Cubes Made of Empire Cement.

MARKS, 94.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,532	100	0	0	Initial load.
29,064	200	.0005	.0002	
43,596	300	.0013	.0009	
58,128	400	.0024	.0016	
87,192	600	.0060	.0043	
116,256	800	.0108	.0084	
145,320	1,000	.0167	.0130	
174,384	1,200	.0225	.0176	First crack.
203,448	1,400	.0291	.0225	
232,512	1,600	.0430	.0312	
235,900	1,623	....	....	Ultimate strength.

TABLE No. 15.

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 95.

Sectional area, 145.20 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,520	100	0	0	Initial load.
29,040	200	.0001	0	
43,560	300	.0004	.0001	
58,080	400	.0007	.0001	
87,120	600	.0013	.0003	
116,160	800	.0022	.0008	
145,200	1,000	.0032	.0013	
174,240	1,200	.0046	.0021	
203,280	1,400	.0063	.0033	
232,320	1,600	.0081	.0044	
261,360	1,800	.0107	.0061	
290,400	2,000	.0135	.0082	
319,440	2,200	.0166	.0103	
348,480	2,400	.0192	.0123	First crack.
377,520	2,600	.0236	.0155	
406,560	2,800	.0280	.0190	
456,000	3,140	....	....	Ultimate strength.
		MARKS, 98.		
		Sectional area, 145.32 square inches. Gauged length, 5 inches.		
14,532	100	0	0	Initial load.
29,064	200	.0001	0	
43,596	300	.0003	0	
58,128	400	.0006	.0001	
87,192	600	.0013	.0002	
116,256	800	.0022	.0007	
145,320	1,000	.0035	.0015	
174,384	1,200	.0048	.0023	
203,448	1,400	.0070	.0036	
232,512	1,600	.0093	.0051	
261,576	1,800	.0119	.0068	
290,640	2,000	.0153	.0094	
319,704	2,200	.0195	.0122	
348,768	2,400	.0244	.0164	First crack.
377,832	2,600	.0310	.0212	
406,896	2,800	.0364	.0260	
413,600	2,846	....	....	Ultimate strength.
		MARKS, 101.		
		Sectional area, 144.12 square inches. Gauged length, 5 inches.		
14,412	100	0	0	Initial load.
28,824	200	0	0	
43,236	300	0	0	
57,648	400	.0002	0	
86,472	600	.0007	0	
115,296	800	.0018	.0003	
144,120	1,000	.0033	.0012	
172,944	1,200	.0056	.0028	
201,768	1,400	.0083	.0045	
230,592	1,600	.0113	.0067	
259,416	1,800	.0147	.0092	
288,240	2,000	.0186	.0121	First crack.
317,064	2,200	.0235	.0158	
345,888	2,400	.0292	.0204	
403,600	2,800	....	....	Ultimate strength.

TABLE No. 15—(*Continued*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 96.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Guaged Length.		Remarks,
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,272	300	.0003	0	
57,696	400	.0006	.0002	
86,544	600	.0012	.0004	
115,392	800	.0019	.0008	
144,240	1,000	.0028	.0012	
173,088	1,200	.0040	.0018	
201,936	1.400	.0056	.0026	
230,784	1,600	.0075	.0038	
144,240	1,000	....	....	Rested under this load 16 hours.
14,424	100	....	.0052	Set after above rest.
259,632	1,800	.0096	.0059	
288,480	2,000	.0116	.0071	
317,328	2,200	.0162	.0105	First crack.
346,176	2,400	.0219	.0150	
375,024	2,600	.0301	.0214	
403,872	2,800	.0550	....	Ultimate strength.

MARKS, 99.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

14,472	100	0	0	Initial lcad.
28,944	200	.0001	0	
43,416	300	.0003	.0001	
57,888	400	.0006	.0001	
86,832	600	.0013	.0004	
115,776	800	.0025	.0011	
144,720	1,000	.0040	.0019	
173,664	1,200	.0062	.0033	
202,608	1,400	.0098	.0058	
231,552	1,600	.0138	.0089	
260,496	1,800	.0179	.0120	
289,440	2,000	.0235	.0167	First crack.
318,384	2,200	.0322	.0235	
351,500	2,429	....	....	Ultimate strength.

MARKS, 102.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

14,412	100	0	0	Initial load.
28,824	200	.0001	0	
43,236	300	.0006	.0001	
57,648	400	.0013	.0006	
86,472	600	.0032	.0019	
115,296	800	.0059	.0039	
144,120	1,000	.0096	.0069	
172,944	1,200	.0135	.0100	
201,768	1,400	.0186	.0140	First crack.
230,592	1,600	.0245	.0189	
259,416	1,800	.0324	.0254	
288,240	2,000	.0408	.0324	
309,900	2,150	....	....	Ultimate strength.

TABLE No. 15—(*Continued*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 97.

Sectional area, 145.08 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Guaged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,508	100	0	0	Initial load.
29,016	200	.0005	.0002	
43,524	300	.0012	.0007	
58,032	400	.0021	.0012	
87,048	600	.0050	.0035	
116,064	800	.0090	.0068	
145,080	1,000	.0147	.0113	First crack.
174,096	1,200	.0234	.0185	
203,112	1,400	.0334	.0267	
231,000	1,591	.0522	....	Ultimate strength.

MARKS, 100.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

14,532	100	0	0	Initial load.
29,064	200	.0006	.0002	
43,596	300	.0016	.0010	
58,128	400	.0029	.0020	
87,192	600	.0076	.0058	
116,256	800	.0139	.0110	
145,320	1,000	.0227	.0184	
170,000	....	....	....	First crack.
174,384	1,200	.0334	.0275	
203,448	1,400	.0487	.0402	
228,300	1,571	....	....	Ultimate strength.

MARKS, 103.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

14,532	100	0	0	Initial load.
29,064	200	.0018	.0014	
43,596	300	.0044	.0038	
58,128	400	.0085	.0072	
72,660	500	.0131	.0112	
87,192	600	.0175	.0150	First crack.
101,724	700	.0235	.0204	
116,256	800	.0288	.0257	
130,788	900	.0348	.0166	
145,320	1,000	.0464	.0410	
159,852	1,100	.0553	.0492	
192,400	1,324	....	....	Ultimate strength.

TABLE No. 15—(*Continued*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 104.

Sectional area, 143.88 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

APPLIED LOADS.		IN GAUGED LENGTH.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,388	100	0	0	Initial load.
28,776	200	.0002	0	
43,164	300	.0005	.0001	
57,552	400	.0007	.0001	
86,328	600	.0012	.0002	
115,104	800	.0017	.0002	
143,880	1,000	.0023	.0005	
172,656	1,200	.0029	.0007	
201,432	1,400	.0036	.0009	
230,208	1,600	.0043	.0011	
258,984	1,800	.0050	.0014	
287,760	2,000	.0060	.0019	
316,536	2,200	.0071	.0025	
345,312	2,400	.0081	.0031	
374,088	2,600	.0096	.0040	
402,864	2,800	.0109	.0045	
431,640	3,000	.0127	.0054	
460,416	3,200	.0156	.0075	
489,192	3,400	.0184	.0091	First crack.
517,968	3,600	.0207	.0106	
546,000	3,795	....	....	Ultimate strength.
MARKS, 104a.				
Sectional area, 144.12 square inches. Gauged length, 5 inches.				
14,412	100	0	0	Initial load.
28,824	200	.0003	.0001	
43,236	300	.0005	.0001	
57,648	400	.0007	.0002	
72,060	500	.0010	.0003	
86,472	600	.0014	.0005	
100,884	700	.0017	.0006	
115,296	800	.0021	.0007	
129,708	900	.0025	.0009	
144,120	1,000	.0029	.0010	
158,532	1,100	.0034	....	
172,944	1,200	.0039	.0014	
187,356	1.300	.0045	....	
201,768	1,400	.0052	.0021	
216,180	1,500	.0062	....	
230,592	1,600	.0068	.0029	
245,004	1,700	.0079	....	
259,416	1,800	.0087	.0040	
273,828	1,900	.0100	....	
288,240	2,000	.0110	.0054	
302,652	2,100	.0127	....	
310,000	....	....	....	First crack.
317,064	2,200	.0140	.0075	
331,476	2,300	.0164	....	
345,888	2,400	.0178	.0102	
398,000	2,762	....	....	Ultimate strength.

TABLE No. 15—(*Continued*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 107.

Sectional area, 145.20 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,520	100	0	0	Initial load.
29,040	200	.0001	0	
43,560	300	.0003	0	
58,080	400	.0005	.0001	
72,600	500	.0007	.0001	
87,120	600	.0009	.0002	
101,640	700	.0012	.0003	
116,160	800	.0013	.0003	
130,680	900	.0016	.0004	
145,200	1,000	.0018	.0005	
159,720	1,100	.0021	.0007	
174,240	1,200	.0025	.0008	
188,760	1,300	.0030	.0010	
203,280	1,400	.0033	.0012	
217,800	1,500	.0038	.0013	
232,320	1,600	.0042	.0014	
246,840	1,700	.0050	.0018	
261,360	1,800	.0056	.0020	
275,880	1,900	.0061	.0024	
290,400	2,000	.0070	.0028	
304,920	2,100	.0079	.0033	
319,440	2,200	.0087	.0037	
333,960	2,300	.0096	.0042	
348,480	2,400	.0105	.0050	
360,000	....	....	....	First crack.
363,000	2,500	.0116	.0056	
377,520	2,600	.0127	.0062	
392,040	2,700	.0141	.0072	
406,560	2,800	.0153	.0080	
421,080	2,900	.0174	.0097	
435,600	3,000	.0207	.0122	
476,000	3,278	....	....	Ultimate strength.

MARKS, 110.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0002	0	
43,236	300	.0005	0	
57,648	400	.0009	.0002	
86,472	600	.0018	.0007	
115,296	800	.0030	.0013	
144,120	1,000	.0049	.0026	
172,944	1,200	.0068	.0038	
201,768	1,400	.0090	.0052	
230,592	1,600	.0128	.0081	
259,416	1,800	.0206	.0151	First crack.
288,240	2,000	.0247	.0187	
385,500	2,675	....	....	Ultimate strength.

TABLE No. 15—(*Continued*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 105.

Sectional area, 144.12 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,412	100	0	0	Initial load.
28,824	200	.0001	0	
43,236	300	.0002	0	
57,648	400	.0005	.0001	
72,060	500	.0008	.0001	
86,472	600	.0010	.0002	
100,884	700	.0012	.0003	
115,296	800	.0015	.0004	
129,708	900	.0018	.0005	
144,120	1,000	.0022	.0006	
158,532	1,100	.0026	.0009	
172,944	1,200	.0032	.0012	
187,356	1,300	.0036	.0012	
201,768	1,400	.0041	.0014	
216,180	1,500	.0048	.0018	
230,592	1,600	.0055	.0020	
245,004	1,700	.0062	.0025	
259,416	1,800	.0070	.0029	
273,828	1,900	.0083	.0037	
288,240	2,000	.0095	.0043	
302,652	2,100	.0107	.0054	
317,064	2,200	.0126	.0066	
331,476	2,300	.0148	.0083	
345,888	2,400	.0175	.0102	
360,000	....	....	....	First crack.
360,300	2,500	.0219	.0138	
374,400	2,598	....	....	Ultimate strength.

MARKS, 106.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

14,424	100	0	0	Initial load.
28,848	200	.0002	0	
43,272	300	.0005	.0001	
57,696	400	.0009	.0002	
86,544	600	.0016	.0006	
115,392	800	.0026	.0011	
144,240	1,000	.0037	.0016	
173,088	1,200	.0051	.0024	
201,936	1,400	.0070	.0035	
230,784	1,600	.0094	.0051	
259,632	1,800	.0121	.0073	
288,480	2,000	.0167	.0103	
317,328	2,200	.0238	.0157	First crack.
346,176	2,400	.0380	....	Ultimate strength.

TABLE No. 15—(*Continued*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 111.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,532	100	0	0	Initial load.
29,064	200	.0005	.0001	
43,596	300	.0010	.0004	
58,128	400	.0015	.0008	
87,192	600	.0029	.0016	
116,256	800	.0046	.0029	
145,320	1,000	.0070	.0044	
174,384	1,200	.0101	.0066	
203,448	1,400	.0134	.0091	
232,512	1,600	.0172	.0120	
261,576	1,800	.0221	.0160	First crack.
290,640	2,000	.0250	.0161	Anomalous behaviour of the micrometer attributed to local yielding of the specimen.
310,000	2,133	.0212	....	Ultimate strength.
		MARKS, 106.		
		Sectional area, 144.96 square inches. Gauged length, 5 inches.		
14,496	100	0	0	Initial load.
28,992	200	.0002	0	
43,488	300	.0005	.0001	
57,984	400	.0010	.0003	
72,480	500	.0016	.0008	
86,976	600	.0025	.0012	
101,472	700	.0036	.0019	
115,968	800	.0050	.0029	
130,464	900	.0071	.0043	
144,960	1,000	.0094	.0061	
159,456	1,100	.0132	.0093	
173,952	1,200	.0172	.0129	
188,448	1,300	.0211	.0162	
189,000	....	....	....	First crack.
202,944	1,400	.0273	.0217	
217,440	1,500	.0455	.0389	
218,200	1,505	....	....	Ultimate strength.
		MARKS, 109.		
		Sectional area, 147.01 square inches. Gauged length, 5 inches.		
14,701	100	0	0	Initial load.
29,402	200	.0004	.0001	
44,103	300	.0010	.0005	
58,206	400	.0020	.0012	
73,505	500	.0033	.0021	
88,206	600	.0047	.0031	
102,907	700	.0066	.0045	
117,608	800	.0098	.0071	
132,309	900	.0115	.0085	First crack.
147,010	1,000	.0151	.0115	
161,711	1,100	.0199	.0156	
176,412	1,200	.0265	.0213	
210,400	1,431	....	....	Ultimate strength.

TABLE No. 15—(*Concluded*).

Compression Tests of Concrete Cubes Made of Champion and Buffalo Portland Cements.

MARKS, 112.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,448	100	0	0	Initial load.
28,896	200	.0011	.0009	
43,344	300	.0025	.0020	
57,792	400	.0049	.0039	
72,240	500	.0079	.0065	
86,688	600	.0120	.0101	
101,136	700	.0176	.0150	
115,584	800	.0231	.0202	First crack.
130,032	900	.0306	.0270	
144,480	1,000	.0390	.0347	
158,928	1,100	.0477	.0428	
179,600	1,243	....	....	Ultimate strength.
MARKS, 113. Sectional area, 144.96 square inches. Gauged length, 5 inches.				
14,496	100	0	0	Initial load.
28,992	200	.0001	0	
43,488	300	.0003	0	
57,984	400	.0007	.0001	
72,480	500	.0012	.0002	
86,976	600	.0015	.0003	
101,472	700	.0019	.0005	
115,968	800	.0025	.0009	
130,464	900	.0031	.0011	
144,960	1,000	.0038	.0015	
159,456	1,100	.0045	.0019	
173,952	1,200	.0054	.0026	
188,448	1,300	.0064	.0032	
202,944	1,400	.0079	.0042	
217,440	1,500	.0095	.0053	
231,936	1,600	.0114	.0067	
246,432	1,700	.0140	.0088	
260,928	1,800	.0177	.0115	
275,424	1,900	.0248	.0180	First crack.
303,800	2,096	....	....	Ultimate strength.

TABLE No. 16.

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 115.

Sectional area, 144.48 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length Compression. Inch.	In Gauged Length Set. Inch.	Remarks.
14,448	100	0	0	Initial load.
28,896	200	.0003	0	
43,344	300	.0008	.0001	
57,792	400	.0013	.0001	
86,688	600	.0024	.0005	
115,584	800	.0038	.0011	
144,480	1,000	.0053	.0017	
173,376	1,200	.0068	.0025	
202,272	1,400	.0088	.0038	
231,168	1,600	.0112	.0054	
260,064	1,800	.0156	.0085	
288,300	1,995	.0220	....	Ultimate strength.

MARKS, 116.

Sectional area, 145.56 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,556	100	0	0	Initial load.
29,112	200	.0002	0	
43,668	300	.0006	0	
58,224	400	.0009	0	
87,336	600	.0016	.0001	
116,448	800	.0026	.0002	
145,560	1,000	.0036	.0005	
174,672	1,200	.0046	.0008	
203,784	1,400	.0058	.0013	
232,896	1,600	.0073	.0020	
262,008	1,800	.0084	.0024	
291,120	2,000	.0100	.0033	
320,232	2,200	.0116	.0044	
349,344	2,400	.0131	.0053	
378,456	2,600	.0153	.0068	
407,568	2,800	.0181	.0090	
436,680	3,000	.0207	.0107	
465,792	3,200	.0242	.0133	
494,904	3,400	.0288	.0168	
506,400	3,479	....	....	Ultimate strength.

MARKS, 119.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0001	0	
43,272	300	.0004	0	
57,696	400	.0005	0	
86,544	600	.0010	0	
115,392	800	.0017	0	
144,240	1,000	.0025	.0001	
173,088	1,200	.0037	.0004	
201,936	1,400	.0047	.0007	
230,784	1,600	.0061	.0013	
259,632	1,800	.0073	.0017	
288,480	2,000	.0093	.0027	
317,328	2,200	.0111	.0038	
346,176	2,400	.0138	.0055	
375,024	2,600	.0179	.0081	
403,100	2,795	....	....	Ultimate strength.

TABLE No. 16—(*Continued*).

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 122.

Sectional area, 146.05 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression Inch.	In Gauged Length. Set. Inch.	Remarks.
14,605	100	0	0	Initial load.
29,210	200	.0002	0	
43,815	300	.0004	0	
58,420	400	.0006	0	
73,025	500	.0009	.0001	
87,630	600	.0012	.0001	
102,235	700	.0015	.0002	
116,840	800	.0020	.0003	
131,445	900	.0025	.0004	
146,050	1,000	.0030	.0005	
160,655	1,100	.0036	.0007	
175,260	1,200	.0042	.0009	
189,865	1,300	.0049	.0011	
204,475	1,400	.0058	.0014	
219,075	1,500	.0070	.0018	
233,680	1,600	.0081	.0024	
248,285	1,700	.0093	.0030	
262,890	1,800	.0107	.0038	
277,495	1,900	.0128	.0050	
292,100	2,000	.0149	.0064	
306,200	....	....	....	First crack.
315,600	2,161	....	....	Ultimate strength.

MARKS, 117.

Sectional area, 145.92 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression Inch.	Set. Inch.	Remarks.
14,592	100	0	0	Initial load.
29,184	200	.0002	0	
43,776	300	.0006	0	
58,368	400	.0010	0	
87,552	600	.0019	.0002	
116,736	800	.0032	.0006	
145,920	1,000	.0044	.0011	
175,104	1,200	.0059	.0019	
204,288	1,400	.0080	.0031	
233,472	1,600	.0100	.0043	
262,656	1,800	.0132	.0066	
291,840	2,000	.0201	.0120	
321,024	2,200	....	....	Ultimate strength.

MARKS, 120.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression Inch.	Set. Inch.	Remarks.
14,472	100	0	0	Initial load.
28,944	200	.0002	0	
43,416	300	.0006	0	
57,888	400	.0010	0	
86,832	600	.0022	.0002	
115,776	800	.0036	.0009	
144,720	1,000	.0053	.0017	
173,664	1,200	.0075	.0030	
202,608	1,400	.0105	.0049	
231,552	1,600	.0160	.0089	
258,000	1,783	....	....	Ultimate strength.

TABLE No. 16—(*Continued*).

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 122.

Sectional area, 145.56 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,556	100	0	0	Initial load.
29,112	200	.0004	0	
43,668	300	.0008	.0001	
58,224	400	.0013	.0002	
72,780	500	.0019	.0003	
87,360	600	.0025	.0005	
101,892	700	.0032	.0008	
116,448	800	.0041	.0011	
131,004	900	.0048	.0015	
145,560	1,000	.0058	.0020	
160,116	1,100	.0070	.0028	
174,672	1,200	.0084	.0036	
189,228	1,300	.0101	.0047	
203,784	1,400	.0119	.0060	
218,340	1,500	.0148	.0081	
232,896	1,600	.0194	.0114	
247,100	1,698	.0270	....	Ultimate strength.

MARKS, 118.

Sectional area, 146.41 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,641	100	0	0	Initial load.
29,282	200	.0010	.0005	
43,923	300	.0022	.0012	
58,564	400	.0033	.0019	
87,846	600	.0062	.0038	
117,128	800	.0099	.0061	
146,410	1,000	.0165	.0109	
169,000	1,154	....	....	Ultimate strength.

MARKS, 121.

Sectional area, 144.84 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,484	100	0	0	Initial load.
28,968	200	.0002	0	
43,452	300	.0007	.0001	
57,936	400	.0013	.0004	
72,420	500	.0023	.0009	
86,904	600	.0040	.0017	
101,388	700	.0060	.0030	
115,872	800	.0085	.0045	
130,356	900	.0118	.0074	
144,840	1,000	.0250	.0186	Ultimate strength.

MARKS, 121c.

Sectional area, 146.05 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,605	100	0	0	Initial load.
29,210	200	.0010	.0006	
43,815	300	.0025	.0013	
58,420	400	.0045	.0029	
73,025	500	.0079	.0053	
87,630	600	.0110	.0076	
101,000	692	.0230	.0179	First crack and ultimate strength.

TABLE No. 16—(*Continued*).

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 124.

Sectional area, 144.36 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,436	100	0	0	Initial load.
28,872	200	.0009	.0004	
43,305	300	.0019	.0008	
57,744	400	.0035	.0017	
72,180	500	.0058	.0034	
86,616	600	.0096	.0062	
101,052	700	.0174	.0123	
112,100	776	....	....	Ultimate strength.

MARKS, 125.

Sectional area, 144.00 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,400	100	0	0	Initial load.
28,800	200	0	0	
43,200	300	.0001	0	
57,600	400	.0002	0	
86,400	600	.0007	0	
115,200	800	.0013	0	
144,000	1,000	.0018	0	
172,800	1,200	.0025	.0001	
201,600	1,400	.0032	.0001	
230,400	1,600	.0038	.0003	
259,200	1,800	.0043	.0004	
288,000	2,000	.0050	.0006	
316,800	2,200	.0058	.0008	
345,600	2,400	.0066	.0012	
374,400	2,600	.0074	.0013	
403,200	2,800	.0083	.0016	
432,000	3,000	.0093	.0019	
460,800	3,200	.0106	.0025	
489,600	3,400	.0120	.0031	
518,400	3,600	.0140	.0041	
547,200	3,800	.0169	.0059	
561,200	3,897	....	....	Ultimate strength.

MARKS, 128.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0002	0	
43,272	300	.0005	0	
57,696	400	.0008	.0001	
86,544	600	.0014	.0001	
115,392	800	.0020	.0002	
144,240	1,000	.0025	.0002	
173,088	1,200	.0031	.0003	
201,936	1,400	.0037	.0005	
230,784	1,600	.0043	.0007	
259,632	1,800	.0051	.0009	
288,480	2,000	.0058	.0011	
317,328	2,200	.0068	.0016	
346,176	2,400	.0076	.0018	
375,024	2,600	.0086	.0023	
403,872	2,800	.0099	.0027	
432,720	3,000	.0112	.0032	
461,568	3,200	.0130	.0043	
490,416	3,400	.0153	.0055	
519,264	3,600	.0192	.0077	First crack.
525,300	3,642	....	....	Ultimate strength.

TABLE No. 16—(*Continued*).

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 126.

Sectional area, 144.72 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,472	100	0	0	Initial load.
28,944	200	.0001	0	
43,416	300	.0003	0	
57,888	400	.0006	0	
86,832	600	.0011	.0001	
115,776	800	.0018	.0002	
144,720	1,000	.0026	.0003	
173,664	1,200	.0034	.0006	
202,608	1,400	.0044	.0009	
231,552	1,600	.0056	.0013	
260,496	1,800	.0073	.0019	
289,440	2,000	.0093	.0030	
318,384	2,200	.0123	.0047	
347,328	2,400	.0175	.0082	
361,000	2,494	....	....	Ultimate strength.
MARKS, 127. Sectional area, 144.72 square inches. Gauged length. 5 inches.				
14,472	100	0	0	Initial load.
28,944	200	.0000	0	
43,416	300	.0001	0	
57,888	400	.0002	0	
86,832	600	.0008	0	
115,776	800	.0017	.0002	
144,720	1,000	.0030	.0006	
173,664	1,200	.0043	.0010	
202,608	1,400	.0067	.0020	
231,552	1,600	.0114	.0047	
258,000	1,782	....	....	Ultimate strength.
MARKS, 130. Sectional area, 144.24 square inches. Gauged length, 5 inches.				
14,424	100	0	0	Initial load.
28,848	200	.0004	0	
43,272	300	.0010	0	
57,696	400	.0016	.0001	
86,544	600	.0028	.0006	
115,392	800	.0041	.0011	
144,240	1,000	.0055	.0019	
173,088	1,200	.0075	.0030	
201,936	1,400	.0102	.0046	
230,784	1,600	.0166	.0091	
247,600	1,717	.0250	....	Ultimate strength.

TABLE No. 16—(*Continued*).

Compression Tests of Cubes Made of Cement Mortar.

Marks, 134.

Sectional area, 145.32 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,532	100	0	0	Initial load.
29,064	200	.0001	0	
43,596	300	.0002	0	
58,128	400	.0005	0	
87,192	600	.0010	0	
116,256	800	.0015	0	
145,320	1,000	.0021	0	
174,384	1,200	.0026	.0002	
203,448	1,400	.0032	.0003	
232,512	1,600	.0038	.0004	
261,576	1,800	.0043	.0005	
290,640	2,000	.0048	.0006	
319,704	2,200	.0053	.0006	
348,768	2,400	.0059	.0007	
377,832	2,600	.0064	.0008	
406,896	2,800	.0070	.0009	
435,960	3,000	.0077	.0011	
465,024	3,200	.0083	.0014	
494,088	3,400	.0093	.0015	
523,152	3,600	.0103	.0020	
552,216	3,800	.0118	.0024	
581,280	4,000	.0143	.0035	Ultimate strength.
Marks, 135. Sectional area, 144.36 square inches. Gauged length, 5 inches.				
14,436	100	0	0	Initial load.
28,872	200	.0002	0	
43,308	300	.0005	0	
57,744	400	.0008	0	
86,616	600	.0013	.0001	
115,488	800	.0018	.0002	
144,360	1,000	.0025	.0003	
173,232	1,200	.0032	.0005	
202,104	1,400	.0040	.0007	
230,976	1,600	.0047	.0010	
259,848	1,800	.0058	.0013	
288,720	2,000	.0068	.0017	
317,592	2,200	.0082	.0022	
346,464	2,400	.0100	.0032	
375,336	2,600	.0122	.0043	
404,208	2,800	.0161	.0066	
429,200	2,973	....	....	Ultimate strength.
Marks, 136. Sectional area, 144.60 square inches. Gauged length, 5 inches.				
14,460	100	0	0	Initial load.
28,920	200	.0002	0	
43,380	300	.0005	0	
57,840	400	.0009	0	
86,760	600	.0017	.0001	
115,680	800	.0027	.0002	
144,600	1,000	.0040	.0008	
173,520	1,200	.0056	.0016	
202,440	1,400	.0078	.0026	
231,360	1,600	.0106	.0046	
260,280	1,800	.0185	.0104	Ultimate strength.

TABLE No. 16—(*Continued*).

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 143.

Sectional area, 144.00 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads. Total pounds.	Applied Loads. Pounds per square inch.	In Gauged Length. Compression. Inch.	In Gauged Length. Set. Inch.	Remarks.
14,400	100	0	0	Initial load.
28,800	200	.0002	0	
57,600	400	.0009	.0001	
86,400	600	.0016	.0002	
115,200	800	.0022	.0004	
144,000	1,000	.0030	.0006	
172,800	1,200	.0037	.0009	
201,600	1,400	.0044	.0011	
230,400	1,600	.0050	.0012	
259,200	1,800	.0059	.0015	
288,000	2,000	.0066	.0017	
316,800	2,200	.0076	.0021	
345,600	2,400	.0086	.0027	
374,400	2,600	.0096	.0032	
403,200	2,800	.0111	.0040	
432,000	3,000	.0125	.0046	
460,800	3,200	.0140	.0054	
489,600	3,400	.0162	.0068	
518,400	3,600	.0190	.0083	
557,200	3,869	....	....	Ultimate strength.

MARKS, 144.

Sectional area, 144.24 square inches. Gauged length, 5 inches.

Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	Remarks.
14,424	100	0	0	Initial load.
28,848	200	.0003	0	
43,272	300	.0007	.0001	
57,696	400	.0011	.0002	
72,120	500	.0015	.0003	
86,544	600	.0019	.0004	
100,968	700	.0022	.0005	
115,392	800	.0027	.0006	
129,816	900	.0031	.0007	
144,240	1,000	.0035	.0009	
158,664	1,100	.0039	.0011	
173,088	1,200	.0042	.0012	
187,512	1,300	.0048	.0015	
201,936	1,400	.0052	.0016	
216,360	1,500	.0057	.0018	
230,784	1,600	.0062	.0022	
245,208	1,700	.0070	.0024	
259,632	1,800	.0078	.0029	
274,056	1,900	.0088	.0036	
288,480	2,000	.0097	.0041	
302,904	2,100	.0110	.0049	
317,328	2,200	.0120	.0054	
331,752	2,300	.0138	.0064	
346,176	2,400	.0156	.0080	
360,600	2,500	.0185	.0099	
375,024	2,600	.0233	.0136	
388,000	2,690	....	....	Ultimate strength.

TABLE No. 16—(*Concluded*).

Compression Tests of Cubes Made of Cement Mortar.

MARKS, 145.

Sectional area, 143.88 square inches. Gauged length, 5 inches.

[Refer to Table No. 1 for full history of blocks.]

Applied Loads.		In Gauged Length.		Remarks.
Total pounds.	Pounds per square inch.	Compression. Inch.	Set. Inch.	
14,388	100	0	0	Initial load.
28,776	200	.0012	.0005	
43,164	300	.0022	.0008	
57,552	400	.0031	.0012	
71,940	500	.0038	.0016	
86,328	600	.0045	.0020	
100,716	700	.0055	.0027	
115,104	800	.0064	.0034	
129,492	900	.0075	.0040	
143,880	1,000	.0090	.0051	
43,164	300	....	....	Rested 16 hours under this load.
143,880	1,000	.0095	.0061	
158,268	1,100	.0103	.0063	
172,656	1,200	.0126	.0078	
187,044	1,300	.0154	.0100	
201,432	1,400	.0216	.0154	
227,500	1,581	....	....	Ultimate strength.

TABLE No. 17.

Moduli of Elasticity of Concrete and Cement Mortar Cubes.

[Refer to Table No. 1 for full history of blocks.]

MARKS.	MODULI OF ELASTICITY BETWEEN LOADS, IN POUNDS PER SQUARE INCH OF—		
	100 and 600.	100 and 1000.	1000 and 2000.
	lbs.	lbs.	lbs.
7	3,571,000	2,812,000	1,667,000
7a	1,786,000	1,452,000	....
12	2,273,000	2,143,000	1,429,000
16	2,083,000	2,045,000	962,000
1	3,571,000	4,091,000	2,500,000
17	1,667,000	1,406,000	....
8	3,125,000	2,647,000	1,190,000
2	1,471,000	1,500,000	....
13	2,273,000	2,143,000	....
18	1,562,000	1,607,000	....
9	1,562,000	1,324,000	....
14	1,087,000	1,154,000	....
3	1,562,000	1,667,000	....
10	1,389,000	1,216,000	....
10a	1,250,000	1,184,000	....
15	1,471,000	1,500,000	....
11	1,087,000	....	....
25	1,786,000	1,800,000	1,163,000
25a	1,471,000	1,216,000	....
4	2,083,000	2,045,000	1,429,000
19	1,923,000	1,800,000	1,282,000
22.	3,125,000	2,812,000	1,667,000
26	1,923,000	1,667,000	....
5	2,500,000	1,956,000	....
20	1,667,000	1,500,000	....
23	1,250,000	1,500,000	....
27	1,562,000	1,364,000	....
21	1,786,000	1,552,000	....
24	2,083,000	1,667,000	....
6	1,667,000	1,452,000	....
28	1,667,000	1,324,000	....
29	2,273,000	2,143,000	1,136,000
34	1,667,000	1,731,000	1,087,000
39	1,786,000	1,800,000	1,087,000
39a	1,562,000	1,323,000	....
30	2,083,000	1,956,000	1,136,000
35	2,778,000	2,250,000	1,429,000
40	2,083,000	1,800,000	....
31	2,500,000	2,045,000	....
36	2,083,000	1,667,000	....
41	1,471,000	1,452,000	....
32	1,667,000	1,364,000	....
37	1,250,000	....	....
42	1,667,000	1,500,000	....
33	1,471,000	1,500,000	....
38	1,562,000	1,046,000	....
43	1,250,000	....	....
44	2,778,000	2,250,000	1,087,000
49	4,167,000	2,500,000	1,219,000
54	2,273,000	2,045,000	1,111,000
45	2,083,000	1,875,000	1,111,000
50	2,273,000	2,143,000	1,562,000
55	2,500,000	1,956,000	....
46	2,083,000	1,800,000	....
51	1,786,000	1,500,000	....
56	1,667,000	1,364,000	....
47	1,316,000	1,184,000	....
52	1,471,000	1,184,000	....
57	1,562,000	1,286,000	....
48	1,389,000	1,154,000	....
53	1,250,000	....	....
58	1,316,000	1,046,000	....
59	2,500,000	2,368,000	1,282,000
62	2,778,000	2,500,000	....
62a	1,667,000	1,500,000	....

TABLE No. 17—(*Continued*).

Moduli of Elasticity of Concrete and Cement Mortar Cubes.

[Refer to Table No. 1 for full history of blocks.]

MARKS.	MODULI OF ELASTICITY BETWEEN LOADS, IN POUNDS PER SQUARE INCH OF—		
	100 and 600.	100 and 1000.	1000 and 2000.
	lbs.	lbs.	lbs.
65	3,125,000	1,562,000	....
60	1,667,000	1,250,000	....
63	1,923,000	1,216,000	....
66	1,667,000	1,216,000	....
61	1,316,000	....	....
64	1,562,000	1,216,000	....
67	1,667,000	1,324,000	....
67a	1,087,000	....	....
68	3,125,000	3,000,000	2,000,000
71	3,571,000	3,000,000	2,000,000
74	3,125,000	2,812,000	1,471,000
69	2,083,000	1,667,000	....
72	1,923,000	1,875,000	....
75	2,500,000	1,731,000	....
70	1,923,000	1,667,000	....
73	1,923,000	1,452,000	....
76	1,667,000	1,286,000	....
77	2,778,000	2,500,000	1,724,000
80	2,273,000	2,368,000	1,351,000
83	3,571,000	2,647,000	1,250,000
78	3,125,000	2,812,000	1,282,000
81	2,083,000	1,452,000	....
84	3,000,000	1,406,000	....
79	1,786,000	1,364,000	....
82	1,389,000	1,184,000	....
82c	1,471,000	....	....
85	1,786,000	1,250,000	....
86	2,778,000	2,647,000	....
89	2,778,000	2,647,000	1,613,000
92	2,500,000	2,045,000	1,163,000
87	2,778,000	2,500,000	1,351,000
90	2,273,000	2,143,000	....
93	2,778,000	1,875,000	....
88	2,500,000	2,045,000	....
91	2,273,000	1,607,000	....
94	1,471,000	1,216,000	....
95	2,500,000	2,368,000	1,471,000
98	2,273,000	2,250,000	1,282,000
101	3,571,000	2,143,000	....
96	3,125,000	2,812,000	1,724,000
99	2,778,000	2,143,000	....
102		1,667,000	....
97	1,667,000	....	....
100	1,389,000	1,046,000	....
103	1,[illegible],000	....	....
104	2,500,000	2,500,000	2,174,000
104a	2,778,000	2,368,000	1,351,000
107	3,571,000	3,461,000	1,724,000
110	2,273,000	1,956,000	....
105	3,125,000	2,812,000	1,389,000
108	2,500,000	2,143,000	1,163,000
111	1,923,000	1,73[illegible]	....
106	1,923,000	1,364,000	....
109	1,562,000	....	....
112	1,316,000	....	....
113	2,083,000	1,[illegible]6,000	....
115	1,316,000	1,250,000	....
116	1,667,000	1,452,000	1,389,000
119	2,500,000	1,875,000	1,020,000
122	2,27[illegible],000	1,800,000	833,000
117	1,471,000	1,[illegible]64,000	1,042,000
120	1,250,000	1,250,000	....
123	1,250,000	1,1[illegible]4,000	....
118	1,042,000	804,000	....
121	1,087,000	....	....

TABLE No. 17—(*Concluded*).

Moduli of Elasticity of Concrete and Cement Mortar Cubes.

[Refer to Table No. 1 for full history of blocks.]

MARKS.	MODULI OF ELASTICITY BETWEEN LOADS, IN POUNDS PER SQUARE INCH OF—		
	100 and 600.	100 and 1000.	1000 and 2000.
	lbs.	lbs.	lbs.
121c	735,000	....	....
124	735,000	....	....
125	3,571,000	2,500,000	1,923,000
128	1,923,000	1,956,000	2,083,000
126	2,500,000	1,956,000	1,250,000
127	3,125,000	1,875,000	....
130	2,045,000	1,250,000	....
134	2,500,000	2,250,000	2,381,000
135	2,083,000	2,045,000	1,724,000
136	1,562,000	1,406,000	....
143	1,786,000	1,875,000	2,000,000
144	1,667,000	1,731,000	1,667,000
145	1,000,000	1,154,000	....

J. W. REILLY, *Major*,
Ordinance Department, U. S. A., Commanding.

Correct,
J. E. HOWARD.

APPENDIX.

ILLUSTRATIONS.

New Vertical Wall at Entrance to Upper Mohawk Aqueduct.

CHAMPLAIN CANAL.—SLIDE IN TOWING-PATH BANK NEAR LOCK 5.

Contract No. 7.—Near Ilion. Section of Improved Erie Canal.

View Showing Condition of Mohawk River Bed at Rexford Flats Dam

TABLE No. 17.

Moduli of Elasticity of Concrete and Cement Mortar Cubes.

[Refer to Table No. 1 for full history of blocks.]

MARKS.	MODULI OF ELASTICITY BETWEEN LOADS, IN POUNDS PER SQUARE INCH OF—		
	100 and 600.	100 and 1000.	1000 and 2000.
	lbs.	lbs.	lbs.
7	3,571,000	2,812,000	1,667,000
7a	1,786,000	1,452,000	....
12	2,273,000	2,143,000	1,429,000
16	2,083,000	2,045,000	962,000
1	3,571,000	4,091,000	2,500,000
17	1,667,000	1,406,000	....
8	3,125,000	2,647,000	1,190,000
2	1,471,000	1,500,000	....
13	2,273,000	2,143,000	....
18	1,562,000	1,607,000	....
9	1,562,000	1,324,000	....
14	1,087,000	1,154,000	....
3	1,562,000	1,667,000	....
10	1,389,000	1,216,000	....
10a	1,250,000	1,184,000	....
15	1,471,000	1,500,000	....
11	1,087,000	....	....
25	1,786,000	1,800,000	1,163,000
25a	1,471,000	1,216,000	....
4	2,083,000	2,045,000	1,429,000
19	1,923,000	1,800,000	1,282,000
22	3,125,000	2,812,000	1,667,000
26	1,923,000	1,667,000	....
5	2,500,000	1,956,000	....
20	1,667,000	1,500,000	....
23	1,250,000	1,500,000	....
27	1,562,000	1,364,000	....
21	1,786,000	1,552,000	....
24	2,083,000	1,667,000	....
6	1,667,000	1,452,000	....
28	1,667,000	1,324,000	....
29	2,273,000	2,143,000	1,136,000
34	1,667,000	1,731,000	1,087,000
39	1,786,000	1,800,000	1,087,000
39a	1,562,000	1,323,000	....
30	2,083,000	1,956,000	1,136,000
35	2,778,000	2,250,000	1,429,000
40	2,083,000	1,800,000	....
31	2,500,000	2,045,000	....
36	2,083,000	1,667,000	....
41	1,471,000	1,452,000	....
32	1,667,000	1,364,000	....
37	1,250,000	....	....
42	1,667,000	1,500,000	....
33	1,471,000	1,500,000	....
38	1,562,000	1,046,000	....
43	1,250,000	....	....
44	2,778,000	2,250,000	1,087,000
49	4,167,000	2,500,000	1,219,000
54	2,273,000	2,045,000	1,111,000
45	2,083,000	1,875,000	1,111,000
50	2,273,000	2,143,000	1,562,000
55	2,500,000	1,956,000	....
46	2,083,000	1,800,000	....
51	1,786,000	1,500,000	....
56	1,667,000	1,364,000	....
47	1,316,000	1,184,000	....
52	1,471,000	1,184,000	....
57	1,562,000	1,286,000	....
48	1,389,000	1,154,000	....
53	1,250,000	....	....
58	1,316,000	1,046,000	....
59	2,500,000	2,368,000	1,282,000
62	2,778,000	2,500,000	....
62a	1,667,000	1,500,000	....

TABLE No. 17—(*Continued*).

Moduli of Elasticity of Concrete and Cement Mortar Cubes.

[Refer to Table No. 1 for full history of blocks.]

MARKS.	MODULI OF ELASTICITY BETWEEN LOADS, IN POUNDS PER SQUARE INCH OF—		
	100 and 600.	100 and 1000.	1000 and 2000.
	lbs.	lbs.	lbs.
65	3,125,000	1,562,000	....
60	1,667,000	1,250,000	....
63	1,923,000	1,216,000	....
66	1,667,000	1,216,000	....
61	1,316,000	....	....
64	1,562,000	1,216,000	....
67	1,667,000	1,324,000	....
67a	1,087,000	....	....
68	3,125,000	3,000,000	2,000,000
71	3,571,000	3,000,000	2,000,000
74	3,125,000	2,812,000	1,471,000
69	2,083,000	1,667,000	....
72	1,923,000	1,875,000	....
75	2,500,000	1,731,000	....
70	1,923,000	1,667,000	....
73	1,923,000	1,452,000	....
76	1,667,000	1,286,000	....
77	2,778,000	2,500,000	1,724,000
80	2,273,000	2,368,000	1,351,000
83	3,571,000	2,647,000	1,250,000
78	3,125,000	2,812,000	1,282,000
81	2,083,000	1,452,000	....
84	3,000,000	1,406,000	....
79	1,786,000	1,364,000	....
82	1,389,000	1,184,000	....
82c	1,471,000	....	....
85	1,786,000	1,250,000	....
86	2,778,000	2,647,000	....
89	2,778,000	2,647,000	1,613,000
92	2,500,000	2,045,000	1,163,000
87	2,778,000	2,500,000	1,351,000
90	2,273,000	2,143,000	....
93	2,778,000	1,875,000	....
88	2,500,000	2,045,000	....
91	2,273,000	1,607,000	....
94	1,471,000	1,216,000	....
95	2,500,000	2,368,000	1,471,000
98	2,273,000	2,250,000	1,282,000
101	3,571,000	2,143,000	....
96	3,125,000	2,812,000	1,724,000
99	2,778,000	2,143,000	....
102		1,667,000	....
97	1,667,000	....	....
100	1,389,000	1,046,000	....
103	1,000,000	....	....
104	2,500,000	2,500,000	2,174,000
104a	2,778,000	2,368,000	1,351,000
107	3,571,000	3,461,000	1,724,000
110	2,273,000	1,956,000	....
105	3,125,000	2,812,000	1,389,000
108	2,500,000	2,[illegible]43,000	1,163,000
111	1,923,000	1,73[illegible],000	....
106	1,923,000	1,364,000	....
109	1,562,000	....	....
112	1,316,000	....	....
113	2,083,000	1,[illegible]56,000	....
115	1,316,000	1,250,000	....
116	1,667,000	1,452,000	1,389,000
119	2,500,000	1,875,000	1,020,000
122	2,273,000	1,800,000	833,000
117	1,471,000	1,[illegible]64,000	1,042,000
120	1,250,000	1,250,000	....
123	1,250,000	1,1[illegible]4,000	....
118	1,042,000	804,000	....
121	1,087,000	....	....

TABLE No. 17—(*Concluded*).

Moduli of Elasticity of Concrete and Cement Mortar Cubes.

[Refer to Table No. 1 for full history of blocks.]

MARKS.	MODULI OF ELASTICITY BETWEEN LOADS, IN POUNDS PER SQUARE INCH OF—		
	100 and 600.	100 and 1000.	1000 and 2000.
	lbs.	lbs.	lbs.
121c	735,000	....	....
124	735,000	....	....
125	3,571,000	2,500,000	1,923,000
128	1,923,000	1,956,000	2,083,000
126	2,500,000	1,956,000	1,250,000
127	3,125,000	1,875,000	....
130	2,045,000	1,250,000	....
134	2,500,000	2,250,000	2,381,000
135	2,083,000	2,045,000	1,724,000
136	1,562,000	1,406,000	....
143	1,786,000	1,875,000	2,000,000
144	1,667,000	1,731,000	1,667,000
145	1,000,000	1,154,000	....

J. W. REILLY, *Major*,
Ordinance Department, U. S. A., Commanding.

Correct,
J. E. HOWARD.

APPENDIX.

ILLUSTRATIONS.

New Vertical Wall at Entrance to Upper Mohawk Aqueduct.

Champlain Canal.—Slide in Towing-Path Bank Near Lock 5.

Contract No. 7.—Near Ilion. Section of Improved Erie Canal.

Showing Concrete Walls Between Lock 46 and Whitesboro Street, at Utica, N. Y. Middle Division.

View of Prism in Village of Fort Plain, Showing New Vertical Wall on Berme Side and Old Vertical Wall with Concrete Underpinning on Towing-Path Side.

General View of Canal Prism Near Warners, N. Y. Middle Division.

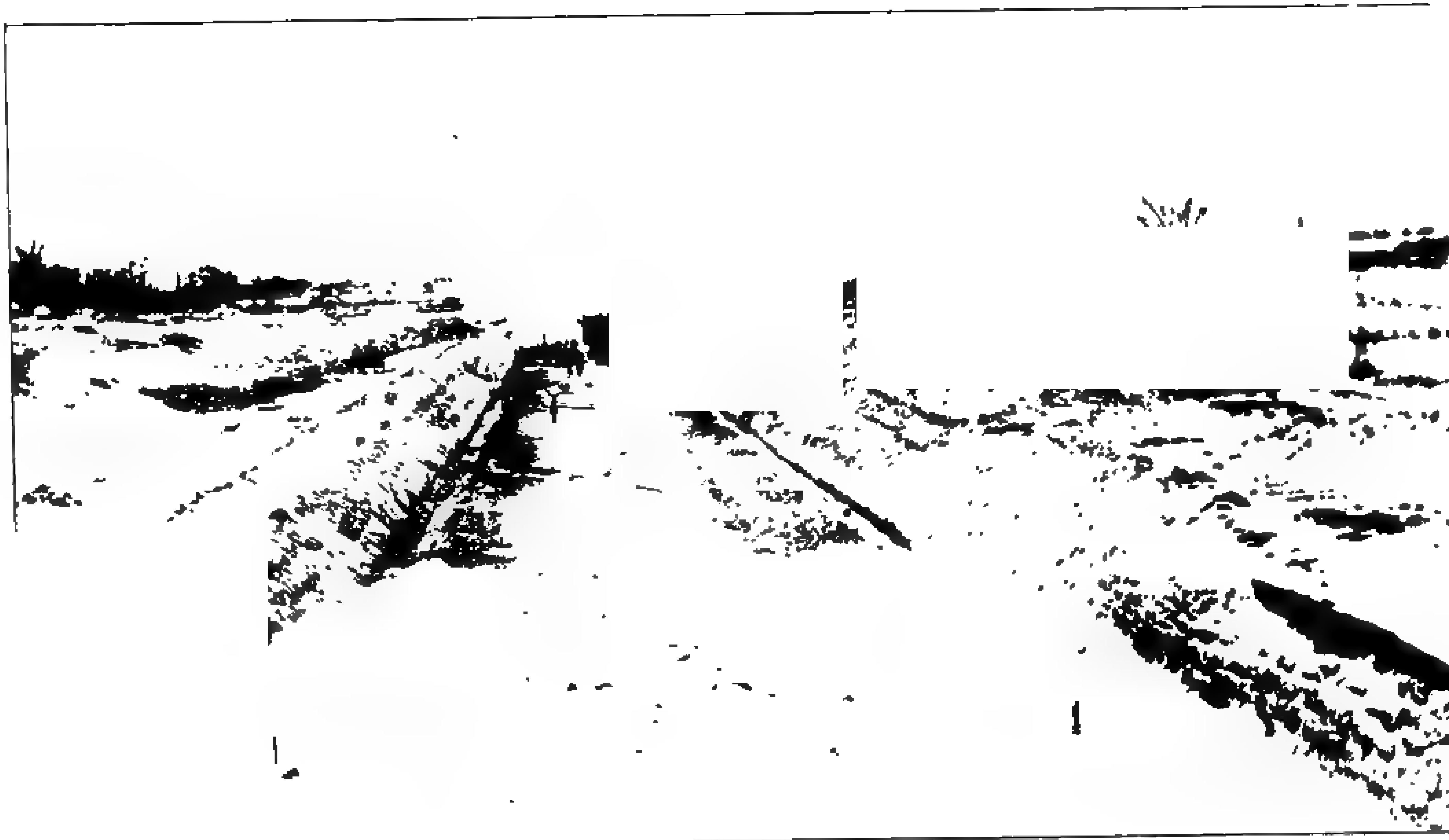
Showing Vertical Wall at Geddes Basin and Method Used to Prevent Sliding. Syracuse, N. Y. Middle Division.

Showing Strata of Marl and Quicksand Near Warners, N. Y. Middle Division.

Showing Caving in of the Towing-Path at Newport, N. Y   Middle Division

Showing Caving in of the Towing-Path at Newport, N. Y Middle Division

Showing Method of Excavating Canal Prism Near Centerport, N. Y. Middle Division.



Showing Method of Excavating Canal Prism Near Centerport, N. Y. Middle Division.

General View of Canal Prism Near Warners, N. Y. Middle Division.

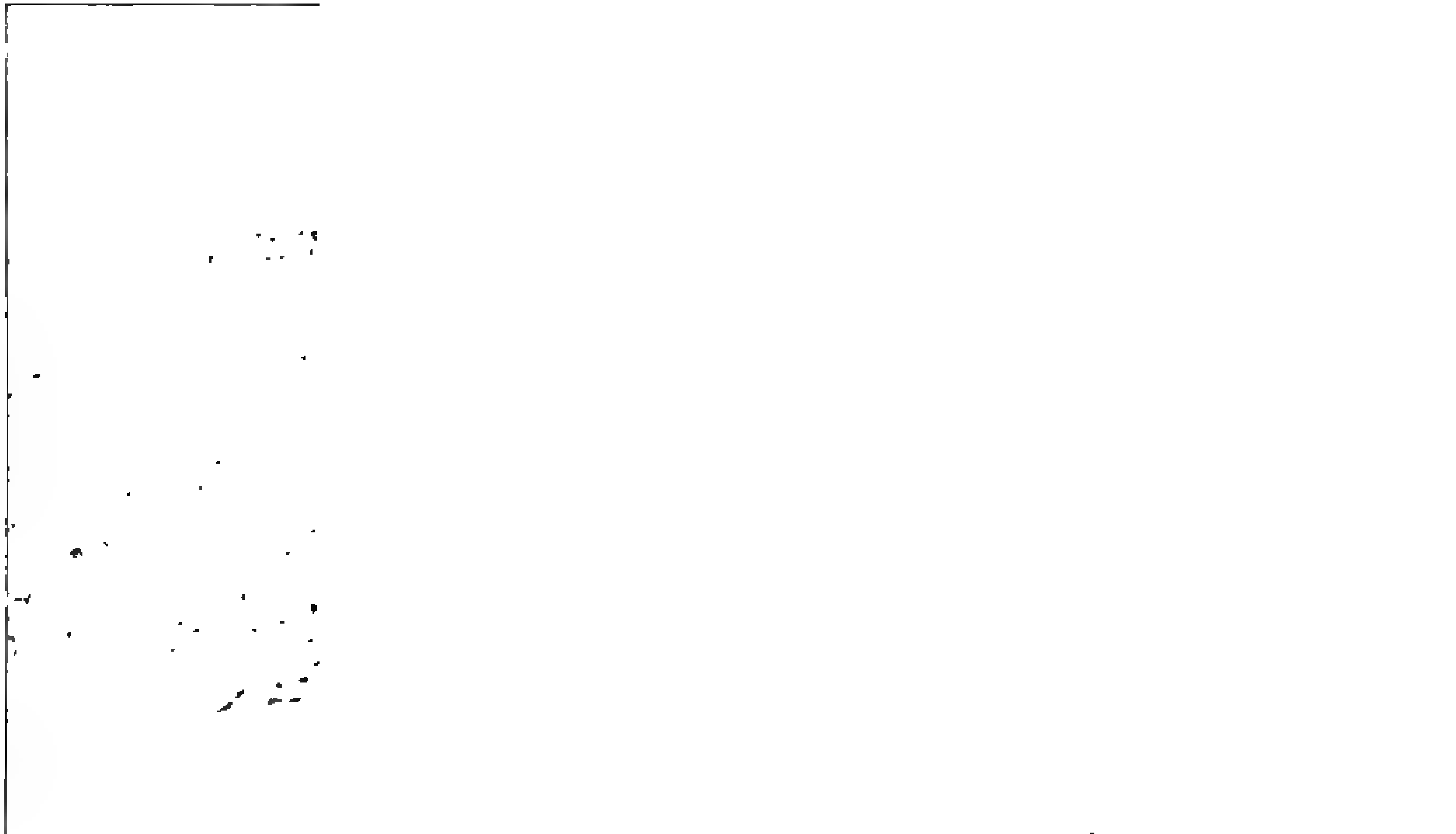
Method of Underpinning Berme Abutment of Beaver Street Bridge at Jordan, N. Y. Middle Division.

New Vertical Wall Between West Genesee Street and Marsh Road at Syracuse, N. Y. Middle Division.

General View of Canal Work Through the Quicksand, Near Warners, N. Y. Middle Division.

Showing Struts Placed in Canal Bottom to Sustain Slope Walls Through Quicksand, Near Warners, N. Y Middle Division.

Truss Used to Brace Abutments to Prevent Sliding into Prism at Newport, N. Y., Middle Division.



Showing Old and New Vertical Berme Walls and Bridge Abutment with Underpinning, at Oriskant, N. Y. Middle Division.

Specimen of Old Slope Wall, Near Oriskany, N Y Middle Division.

Old Vertical Wall Near Syracuse Weigh Lock, Showing Characteristic Disintegration.

Specimen of Old Vertical Wall Between Rome and Oriskany. Middle Division.

Showing New Slope Wall and Excavator at Work Near Warners, N. Y. Middle Division

Showing Struts in Process of Construction Through Quicksand Near Warners, N. Y. Middle Division.

LOCK 51, BLACK RIVER CANAL.—SHOWING CHARACTERISTIC DECAY OF OLD STRUCTURES.

Lock 51, Black River Canal.—Showing Effect of Time on Structure.

Disintegrated Masonry of Lock 61, Black River Canal.

Disintegrated Masonry of Lock 51, Black River Canal.

Disintegrated Masonry of Lock 51, Black River Canal.

Characteristic Piece of Old Road to Woodhull Lake Reservoir in the Adirondacks.

Old Road from North Lake to Canachagala Lake Reservoir —Not Very Good Even for the Adirondacks?

NEW

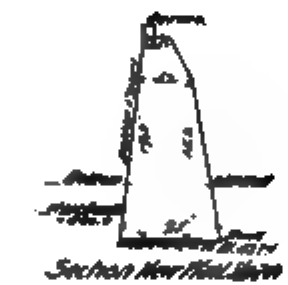
NEW ROAD TO SAND LAKE RESERVOIR.

New Road to Sand Lake Reservoir.

New Road from North to South Lake.

Condemned malt house.

Station 208.



VERTICAL WALL WORK, SLIP NO. 3 TO STATION 208.

Vicinity 97.

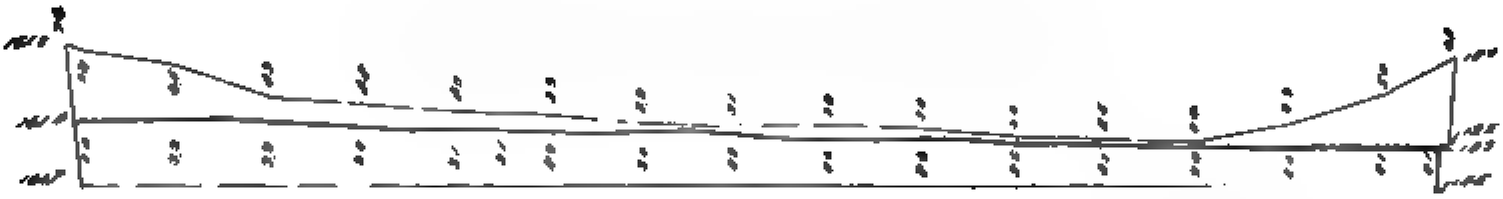
CONTRACT NO. 1.—DIVISION WALL BETWEEN BLACK ROCK HARBOR AND ERIE CANAL, AS OF AUGUST 7, 1897. CANAL EXCAVATED TO NEW GRADE.

Contract No. 1 Portion of Canal, Vicinity of Fort Porter, Station 128 to 132. Shows Spoil Bank and Completed Section of Canal, August 7, 1897.

Hudson
street
bridge.

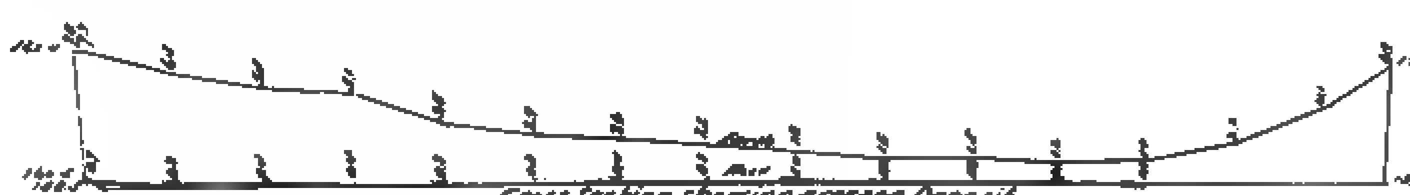
CONTRACT NO. 1.—WORK IN VICINITY OF HUDSON STREET. TYPICAL SECTION BELOW.

Contract No. 1 Drilling Rock, Vicinity Station 180 Section Below.

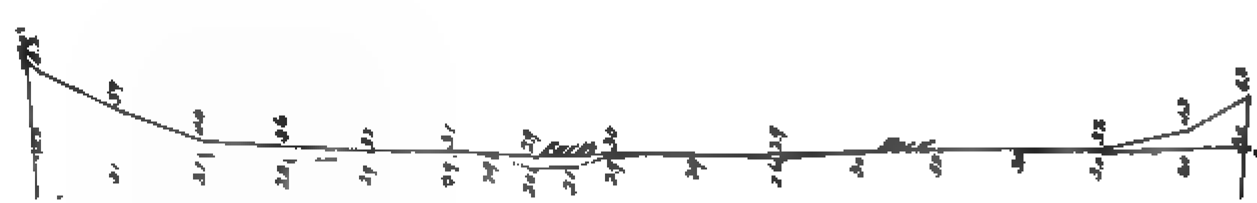


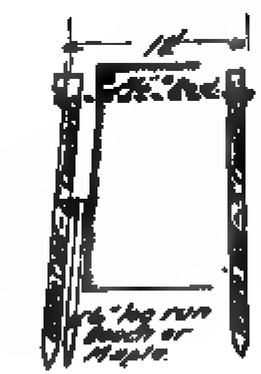
CONTRACT NO. 1.—WORK IN VICINITY OF STATE YARD, BUFFALO. CROSS SECTION SHOWS HEAVY ROCK CUTTING.

CONTRACT No. 1.—VIEW OF CANAL, STATION 193 TO 200, AUGUST 7, 1897, SHOWING CONDITION OF BOTTOM JUST BEFORE WATER WAS LET IN. THIS PORTION WAS LEFT TO BE DREDGED, BEING ALL EARTH. THE ROW OF PILING AT THE RIGHT WAS PLACED TO RETAIN OLD WALL, WHICH HAD ITS FOUNDATION THREE FEET ABOVE GRADE.



Contract No. 1.—Excavating Rock Near Station 185. Section of Excavation Shown Below.





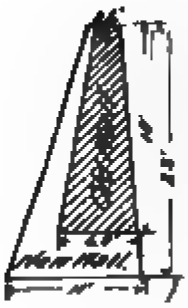
Contract No 1.—Pile and Sheet Pile Protection, in Front of Old Vertical Wall, West Side of Canal from Station 195 to

CONTRACT NO. 1 STONE DEPOSITED ALONG NIAGARA RIVER SIDE OF BIRD ISLAND PIER. STONE FROM EXCAVATION IN ERIE CANAL.

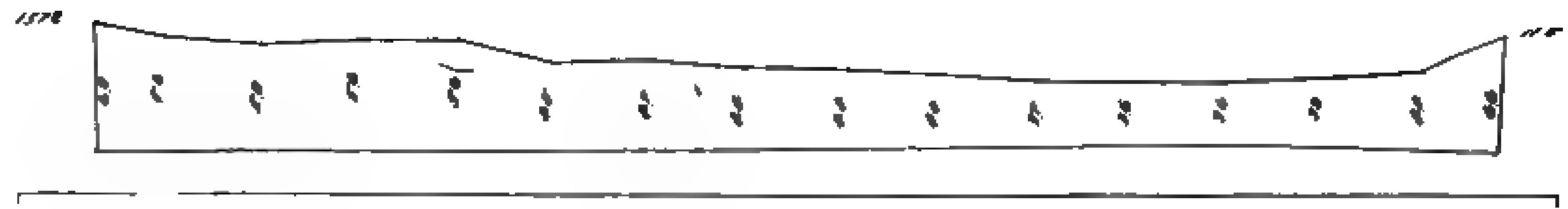
Bird Island Pier, Buffalo.—Showing Effect of the Gale on Lake Erie, November 6, 1897. The Rip Rap Deposited During Summer of 1897 was Almost Entirely Washed Away Stone Either Carried into Niagara River by Undertow or Washed Over the Pier into Black Rock Harbor.

Bird Island Pier, Buffalo.—Showing Effect of the Gale on Lake Erie, November 5, 1897. The Rip Rap Deposited During the Summer of 1897 was Almost entirely Washed Away. Stone Either Carried into Niagara River by Undertow or Washed Over the Pier into Black Rock Harbor.

BIRD ISLAND PIER, BUFFALO.—SHOWING EFFECT OF THE GALE ON LAKE ERIE, NOVEMBER 5, 1897. THE RIP RAP DEPOSITED DURING THE SUMMER OF 1897 WAS ALMOST ENTIRELY WASHED AWAY. STONE EITHER CARRIED INTO NIAGARA RIVER BY UNDERTOW OR WASHED OVER THE PIER INTO BLACK ROCK HARBOR.



CONTRACT No. 1.—TYPICAL SECTION OF OLD VERTICAL WALL, COMPOSED OF TWO FACE WALLS FILLED IN CENTER WITH SPALLS. NOTE DIFFERENCE IN WIDTH OF BASE OF OLD WALL AND NEW ONE JUST STARTED; ALSO THAT ON REMOVING EARTH BACK OF WALL THE REAR FACE BULGED INWARD, DUE TO ABSENCE OF BOND.



Contract No. 1.—Excavation Near Slip No. 3, Station 203+75. Average Cross Section at This Point Shown Above. Note Average Cutting of 4.8 Feet for Width of 157 Feet. This Material is Largely Made up of Deposit from Genesee Street Sewer.

Contract No 1.—View of Ruined Coffer Dam, Slip No. 2, and New Dam in Process of Construction. On March 14, 1897, in the Afternoon, the Original Knee Dam Gave Away, Due to Extreme High Water in Lake Erie, Caused by a Gale.

Contract No. 1.—Spoil Bank Between Jersey and Georgia Streets. Area Covered 275+800 feet, from 10 to 35 Feet High.

Contract No. 1.—Underpinned Vertical Wall, Station 171+50 to 174, Slid Out on November 5, 1897. Photo Shows Original Poor Construction. It was Due to This and to Heavy Load of Concrete Blocks (not Shown on Photo) Placed There for Shipment to Buffalo Breakwater.

Contract No. 1.—View in Front of Buffalo Sand Stone company's Works, Station 210, Showing Manner in Which Vertical Walls are Overloaded by Parties Occupying Land Adjacent. Large Deposits of Sand at This Point Formed by Waste from Stone Saws.

Contract No. 1.—Rebuilding Walls Near Genesee Street, Buffalo

Taking out
Georgia street
bridge.
Runways
on mud.

Contract No. 1.—Timber Driveways on Mud to Prevent Teams Miring, 5,100 Lineal Feet of this Form of Driveway was Laid Using 336,000 Feet (B. M.) of Plank.

CONTRACT NO. 1.—VIEW OF RUINED COFFER DAM, SLIP NO. 3, AND NEW DAM IN PROCESS OF CONSTRUCTION. ON MARCH 14, 1897, IN THE AFTERNOON, THE ORIGINAL KNEE DAM GAVE AWAY, DUE TO EXTREME HIGH WATER IN LAKE ERIE, CAUSED BY A GALE. THIS VIEW SHOWS PROGRESS OF WORK ON NEW CRIB COFFER DAM, NINETEEN HOURS AFTER FAILURE OF THE OTHER. AT 8 P. M., MARCH 19TH, CRIB WAS IN PLACE AND FILLED AND PUMPS STARTED

CONTRACT NO. 1.—JUNCTION OF NEW AND OLD WALL, STATION 87.

Station 173.

Contract No. 1. General View of Work from Hudson Street Bridge, South. The Underpinned Wall on the Left from Ladder to Beyond the Incline, Caved in November, 1897, About Four Months After Water was let in. In the Scope of This View Three Pumps were Maintained, One Centrifugal and Two Worthingtons.

Station 173.

Contract No. 1—General View of Work from Hudson Street Bridge, South. The Underpinned Wall on the Left from Ladder to Beyond the Incline, Caved in November, 1897, About Four Months After Water was let in. In the Scope of This View Three Pumps were Maintained, One Centrifugal and Two Worthingtons.

Contract No. 1.—View of Erie Basin, Showing Canal Boats Blocking the Approach to Docks, Due to Their Being Unable to Occupy Other Portions of the Basin on Account of Insufficient Depth of Water and Numerous Wrecks.

Contract No. 1.—View Showing Method of Underpinning Old Vertical Walls. Portion at Left Blocked up and Section Undermined, at Right, Section Underpinned. At This Point the Timber Foundation was Within One Foot of Rock Bottom, a Common Occurrence.

Contract No. 1.- View of Old Wall Illustrates General Conditions Through Buffalo, and Demonstrates the Futility of Attempting to Underpin.

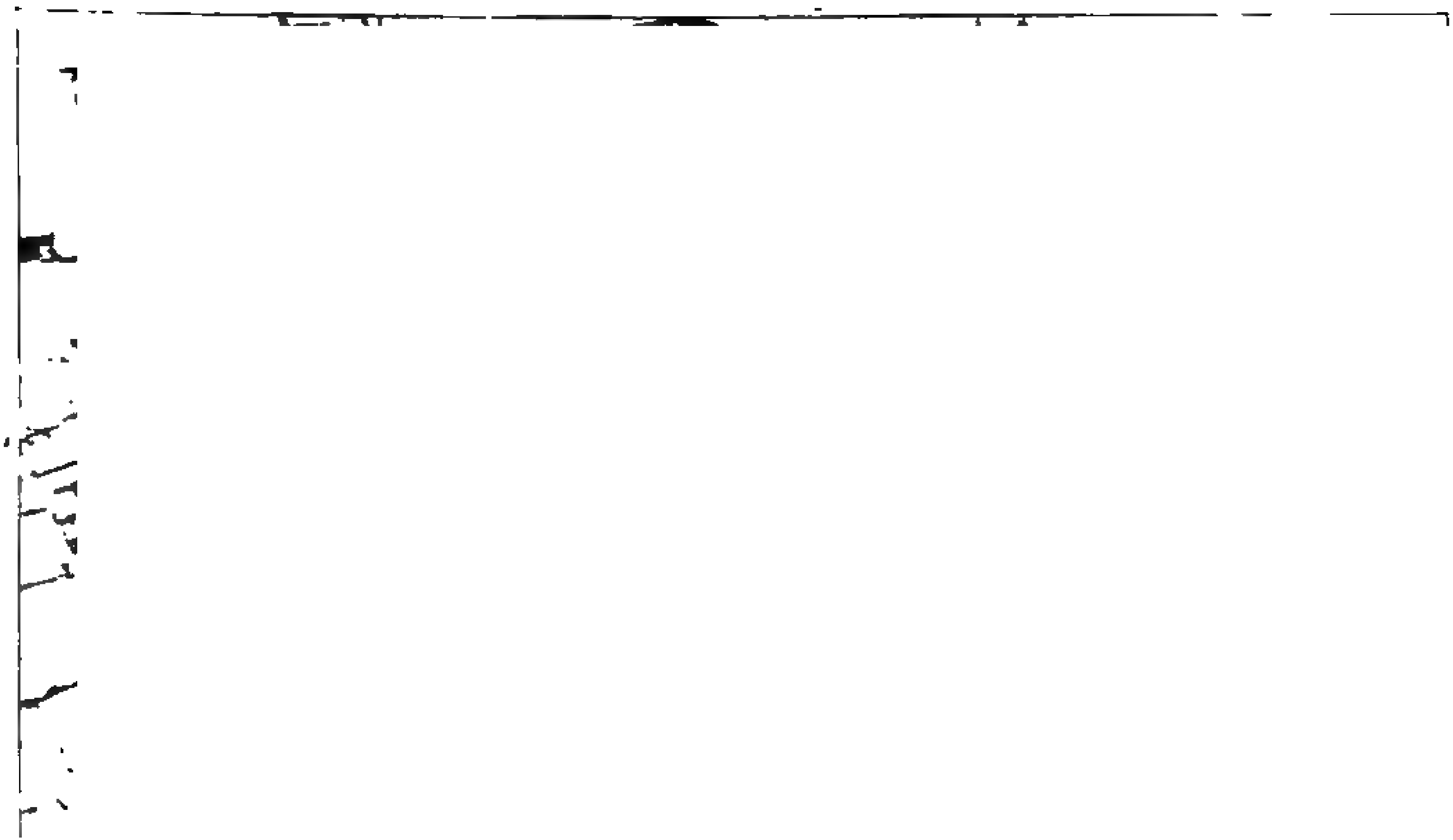
CONTRACT NO. 1.—DIVISION WALL BETWEEN BLACK ROCK HARBOR AND THE CANAL, SHOWING OLD CRIBS RESTING ON EARTH, FIVE TO SIX FEET ABOVE BED OF CANAL. HEAD OF WATER ON OTHER SIDE, EIGHT FEET. VIEW TAKEN AUGUST 7, 1897, STATION 127.

CONTRACT NO. 1.—ALBANY STREET STORM OVERFLOW SEWER. SHOWS EFFECT ON BOTTOM OF CANAL, DISPLACING MATERIAL IN BOTTOM.

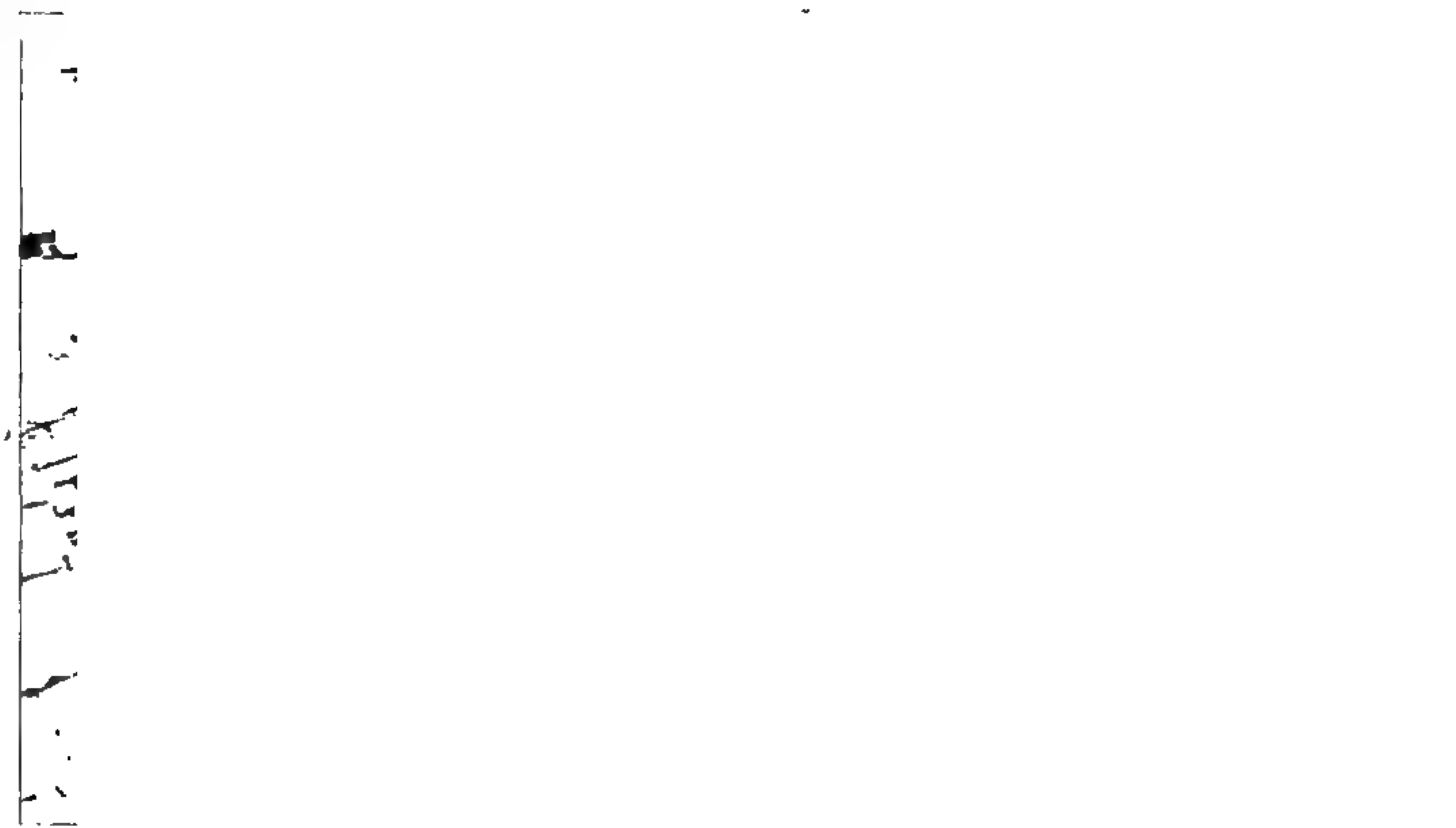
...TION 295. SHOWING METHOD OF REBUILDING VERTICAL WALLS BY TAKING DOWN SHORT SECTIONS OF OLD WALL...

... OR ROCK TO ...

Contract No. 1.—View of Bed of Canal, August 7, 1897, Ferry Street to Water-Works, Station 88 to 125. International Bridge in Distance.



Contract No. 1.—View of Old Vertical Wall with Timber Foundation on Rock, Station 217. A Large Portion of the Vertical Wall in Buffalo was on Timber Foundation Resting on Rock or Within a Few Inches of the Rock. Timbers were Roughly Hewed, and in Many Cases so Round that they Rolled out when Material was Taken from in Front of Them, Letting Walls Down.



CONTRACT NO. 1.—VIEW OF OLD VERTICAL WALL WITH TIMBER FOUNDATION ON ROCK, STATION 217. A LARGE PORTION OF THE VERTICAL WALL IN BUFFALO WAS ON TIMBER FOUNDATION RESTING ON ROCK OR WITHIN A FEW INCHES OF THE ROCK. TIMBERS WERE ROUGHLY HEWED, AND IN MANY CASES SO ROUND THAT THEY ROLLED OUT WHEN MATERIAL WAS TAKEN FROM IN FRONT OF THEM, LETTING WALLS DOWN.

Contract No. 1.—Rebuilding Walls Near Grand Trunk Freight House, Between Charles and Erie Streets.

CONTRACT NO. 1.—WALLS IN VICINITY COMMERCIAL STREET, BUFFALO.

CONTRACT NO. 1.—DRIVING SHEET PILING IN FRONT OF VERTICAL WALLS NEAR COMMERCIAL STREET, BUFFALO, TO PROTECT WALLS AND BUILDINGS AFTER DEEPENING IS COMPLETED. THIS SECTION OF THE CANAL WAS FILLED WITH SEWAGE, WHICH COULD ONLY BE REMOVED BY DREDGING.

Contract No. 1.—Walls in Vicinity of Commercial Street.

Contract No. 1.—Erie Street Bridge, East End, Showing Undermined Abutment Wall, Caused by Break in City Sewer During Heavy Rain Storm on July 10, 1897.

CONTRACT NO. 1.—ERIE STREET BRIDGE, WEST END. THIS BRIDGE FELL IN CANAL JULY 10, 1897, DUE TO DEFECTIVE SEWER UNDERMINING NORTH ABUTMENT, WHILE WORK WAS BEING UNDERPINNED.

CONTRACT NO. 1.—SLIP NO. 1, AUGUST 7, 1897, JUST BEFORE WATER WAS LET IN. LOOSE STONE AT LEFT REMOVED BEFORE WATER WAS LET IN. COFFER DAM IN BACKGROUND.

Contract No. 1.—Slip No. 2, August 7, 1897, Just Before Water was let in. Coffer Dam in Place at End of Slip.

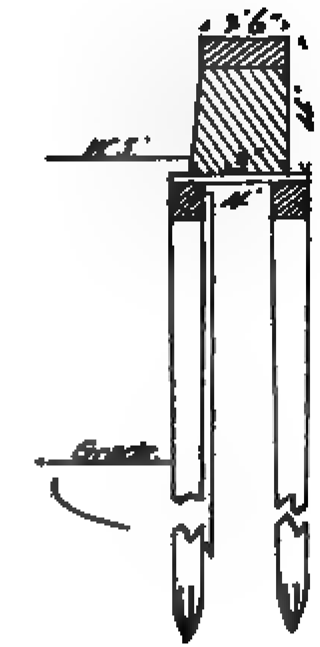
Contract No. 1.—Defective Dock, Slip No. 2, Showing Condition Before Work of Bottoming out and Rebuilding Dock Commenced.

Contract No. 1, Western Division.—Slip No. 2, at Buffalo, Showing New Timber Cribs and Wall.

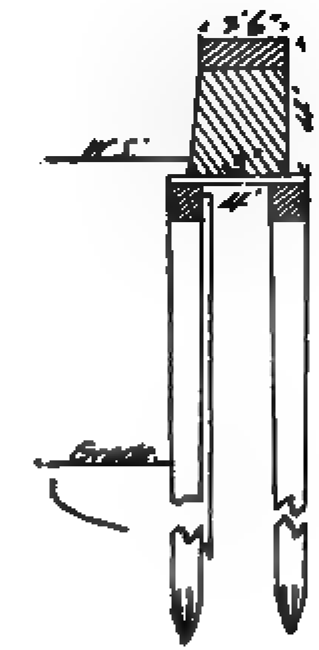
CONTRACT NO. 1.—SLIP NO 2; NEW VERTICAL WALLS ON CRIBS. (NOTE OLD CONSTRUCTION AT END OF [illegible]

Contract No. 1.—Slip No. 2: New North Wall and Cribs.

CONTRACT NO. 1—SLIP NO. 2, SHOWING COMPLETED WALL. SECTION OF WALL SHOWN AT SIDE. (THIS VIEW IS REVERSED.)



Contract No. 2.—Finished Wall, Pendleton, March 29, 1897. Vertical Wall on Pile Foundation at Pendleton, 3,500 Feet Long.



CONTRACT NO 2.—FINISHED WALL, PENDLETON, MARCH 29, 1897. VERTICAL WALL ON PILE FOUNDATION AT PENDLETON, 3,500 FEET LONG.

Contract No. 2.—Wall and Cribs Pushed out of Line Near Black Rock, Held from Further Sliding by [illegible]-Inch Iron Dowels in Rock in Front of Cribs.

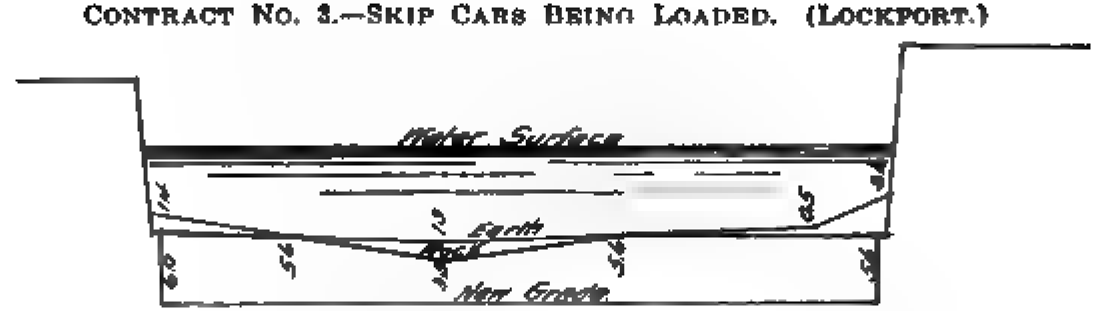
CONTRACT No. 2.—CRIBS AT TIMBER YARD NEAR FERRY STREET, BUFFALO, JUNE 11, 1897.
... CANAL AND WAS REBUILT WITH TIMBER CRIBS
... SEWER.

Line of
sheet pilin
for old sew

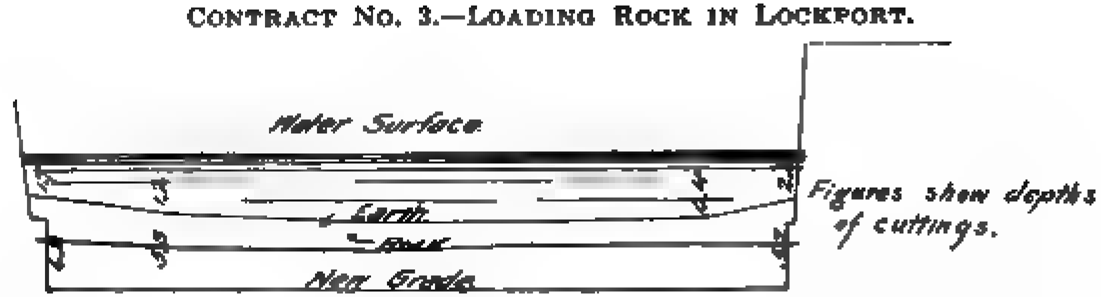
CONTRACT NO. 2.—SINKING CRIB AT MANNING'S MALT HOUSE, JUNE 11, 1897.

Contract No. 2.—Crib and Vertical Wall Work at Black Rock. Shows Anchor Rods from Cribs to "Dead Men" in Solid Earth.

CONTRACT NO. 2.—SKIP CARS BEING LOADED. (LOCKPORT.)



CONTRACT NO. 3.—LOADING ROCK IN LOCKPORT.



(Lockport.)

Contract No. 3.—Dam in "Rock Cut" to Keep Water off Work During the Day Surplus Water Wasted Over Work Each Night.

Contract No. 7.—Near Medina. Old and New Vertical Walls.

Contract No 7. Near Medina. Note the Condition of Old Walls and Number of Places that have Fallen Down. No Work of Deepening yet Done Here

Contract No. 7.—Near Medina. Note the Difference in Character of Old and New Walls.

Contract No 7.—Near Medina. Old Wall with Timber Coping. No Deepening yet Done, but Old Walls Falling Down.

New Head Wall, Medina Road Culvert.

South Side of Porter Avenue Bridge, Buffalo, N. Y.

Length of span, 188 feet; width, 100 feet; width of roadway, 50 feet; width of walks, 25 feet; clear height at center above water surface, 26½ feet.

Contract No. 1.—Completed Work, Vicinity of Porter Avenue, August 7, 1897.

NEWARK WASTE-WEIR.—INLET SIDE.

Cartersville Waste-Weir.—Original Structure. Rebuilt Winter 1896-7.

CONTRACT NO. 4.—CARTERSVILLE WASTE-WEIR, REBUILT WINTER 1896-97; 961 CUBIC YARDS MASONRY, 268 CUBIC YARDS CONCRETE; COST, $11,097.47.

Cartersville Waste-Weir.—Showing Tow-Path Bridge.

CONTRACT NO. 1.—MCMYLER REVOLVING DERRICKS. ONE MACHINE PASSING SKIP TO THE OTHER. SECTION SHOWN BELOW

W.—Bottom of wall.
C.—Top of channelling.

CONTRACT NO. 2.—SMALL DREDGE, 4-FOOT DRAUGHT, ½-YARD DIPPER, USED FOR DREDGING UNDER BRIDGES AND IN CRAMPED POSITIONS.

CONTRACT No 2.—SKIDDING LARGE DREDGE FROM NIAGARA RIVER INTO THE CANAL FOR WORK IN TONAWANDA CREEK. DREDGE TOO LARGE FOR LOCKS.

Contract No. 2.—Skidding Dredge from Niagara River into Canal.

Contract No. 3.—Large Derrick, 106-Foot Boom, Hoisting 3 Cubic Yard Skips from Scow. (On High Bank, Near Lockport.)

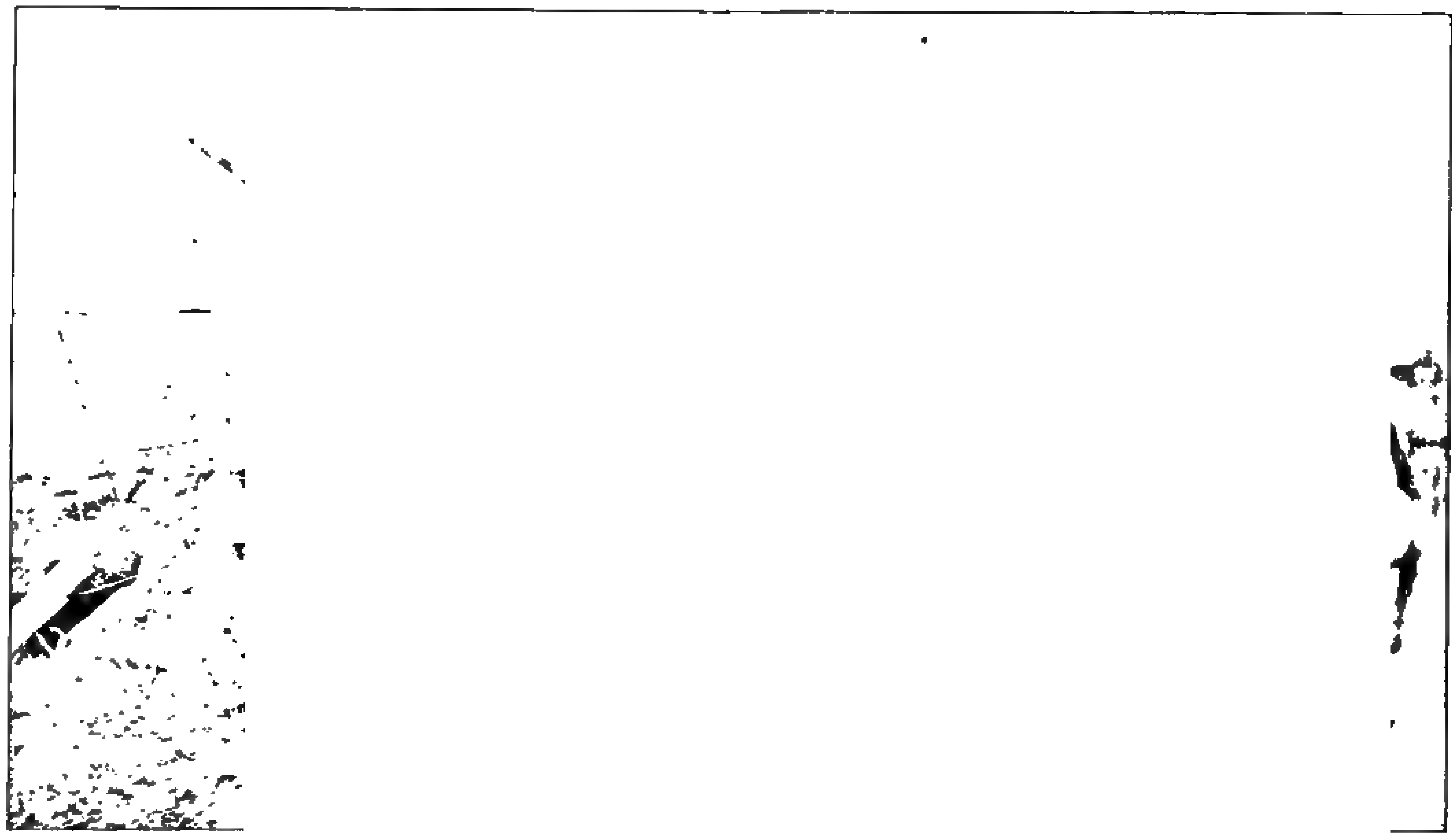
Contract No. 3.—Revolving Derrick, 90-Degrees Swing, 3-Yard Skip, Boom 106 Feet Long, 96 Feet Effective Reach.

Contract No. 5, Eastern Division.—Osgood Dredge Used by Brummelkamp & Lane.

CONTRACT NO. 5.—PILE SAW, SAWING OFF PILES DRIVEN AT TOE OF SLOPE.

Contract No. 5. Driving Piles at Foot of Slope Walls with Water in Canal.

Contract No 2.—Drill Boat at Black Rock, Drilling in Front of Cribs on Rock and Placing 3-Inch Iron Dowels in Holes to Prevent Cribs Sliding.



CONTRACT NO. 6.—DERRICK BOAT FOR UNLOADING GRAVEL, STONE, ETC.

Designed and built by Grannis & O'Conner, contractors. Length of hull, 90 feet; width of hull, 17 feet; length of boom, 35 feet; $\frac{5}{8}$-inch steel wire cable for hoisting, $\frac{1}{2}$-inch steel wire cable for swinging; $\frac{1}{2}$ cubic yard bucket; H. B. Boiler; coal consumption, $\frac{1}{2}$ ton in 24 hours.

Contract No. 1.—Excavating Rock and Earth, Vicinity Station 120. Two McMyler Revolving Derricks, 55-Foot Boom, 1½ Yards Skip, 50 Laborers, 5 Skilled Men. Average Yardage, 10 hours, About 400 Cubic Yards. Typical Section Shown Below.

CONTRACT NO. 3.—DREDGING IN SKIPS.

CONTRACT No. 5.—DREDGE No. 2.

Machinery made by Jno. Featherstone & Son, Chicago, Ill. Machinery designed by Racine Dredging Co., H. B. Whitney, foreman. Length of hull, 70 feet; width of hull, 17 feet 6 inches; width of pontoons, 5 feet; length of boom, 35 feet; size of bucket, $1\frac{1}{2}$ cubic yards; $\frac{7}{8}$-inch steel wire cable for hoisting; $\frac{3}{4}$-inch steel wire cable for swinging; steam spud, hoists with $\frac{3}{4}$-inch steel wire cable; 50 horse-power locomotive boiler, coal consumption, 3 tons in 24 hours.

Contract No. 12.—Osgood Excavator Used by Shear & Haight.

Contract No. 10, Champlain Canal. Elevator Dredge Used by Mahan & Sundstrome.

Contract No. 10, Champlain Canal. Elevator Dredge Used by Mahan & Sundstrom.

CONTRACT NO. 1—PUMPING PLANT NEAR WATER-WORKS; ONE 6-INCH CENTRIFUGAL PUMP IN CANAL, ONE 12-INCH IN BOAT. STEAM FROM BOAT "RAMBLER," IN BLACK ROCK HARBOR.

CONTRACT NO. 1.—HOISTING MATERIAL FROM CANAL ON CARS WITH MCMYLER REVOLVING DERRICKS.

CONTRACT NO. 1.—SLIP NO. 2, WALLS. DIVER DESCENDING FOR LOOSE ROCK IN CHANNEL.

Contract No. 1.—Pumping Plant Near Water-Works; One 6-Inch Centrifugal Pump in Canal, One 12-Inch in Boat. Steam from Boat "Rambler," in Black Rock Harbor.